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CARDIAC CHANGES IN ARTERIOVENOUS FISTULA*

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ONE of the most frequent and serious vascular injuries of modern warfare is arteriovenous fistula. Multiple injuries of blood vessels, peripheral nerves, and bones result from high explosive shell fragments, bombs, grenades and mines. The opportunity to study the cardiac changes in a large number of patients with arteriovenous fistula was provided by the designation of Ashford General Hospital as a Vascular Surgery Center. Detailed reports concerning the diagnosis and surgical treatment of this condition have been made by Elkin.[2,3]

The effects of an arteriovenous fistula upon the circulation in general and the heart in particular are so important that the attention of roentgenologists should be called to the cardiac changes incident to this lesion. As these changes are usually reversible by elimination of the fistula, it is important that their cause be recognized. The heart changes of beriberi, myxedema and hyperthyroidism are to some extent reversible.[24] Constrictive pericarditis and patent ductus arteriosus offer brilliant examples of the beneficial effect of surgery; the improvement following surgical elimination of an arteriovenous fistula is equally dramatic.

William Hunter, in 1757, first described arteriovenous fistula of the vessels of the forearm as a result of blood letting. In 1888, Delbet described 250 cases, of which 96 were the results of venesection.[15] Von Haberer reported 243 cases occurring in German soldiers as a result of wounds received in the first World War.[12] Matas,[14] in reviewing 620 operations on major blood vessels, reported 67 cases from civilian practice. The cardiac manifestations of arteriovenous aneurysms resulting from wounds incurred in the present war may not be evident, in some cases, until after the soldier is discharged. As a result, the condition may be encountered more frequently in civilian practice. Any patient exhibiting cardiac enlargement without obvious cause, who has received battle injuries, should be carefully examined for an arteriovenous fistula. This includes auscultation of all wounds.[3] In this connection, the following is a quotation from the late Mont R. Reid's contributions[21] on arteriovenous communications:

> It is too true that we often fail to appraise properly chronic affections which, while life lasts, are no serious handicap to the individual. In cases of such affections, it becomes our duty to think of the future, of the days longer our patient may be enabled to live, and not of the day he is living when he comes to the office. It is in such manner that most abnormal ar-

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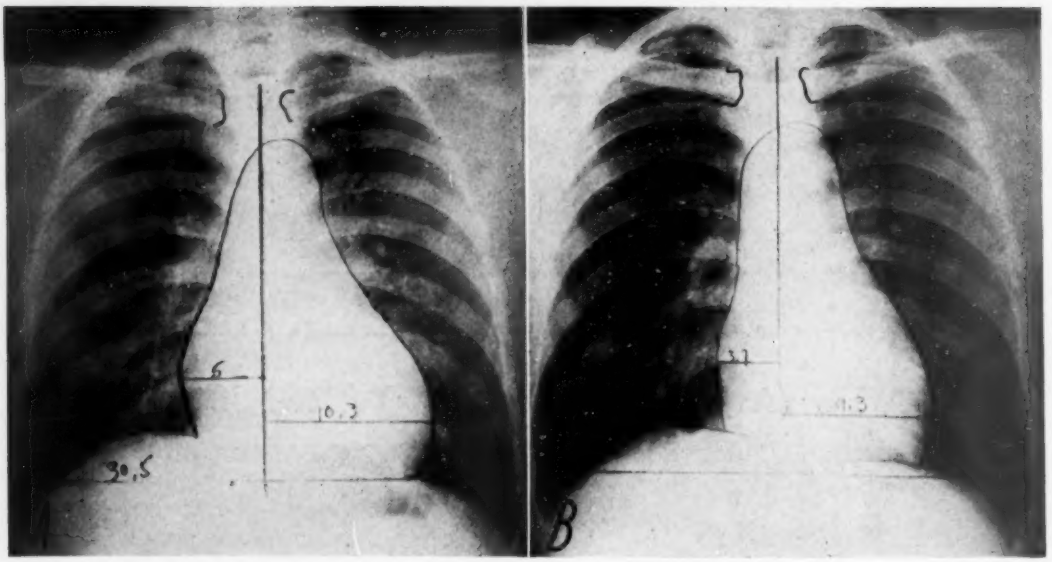


Fig. 1. Case 1. Wound of left leg December 6, 1942. Profuse bleeding. Cast for two months, followed by physiotherapy. Shrapnel removed from wound June, 1943. Further physiotherapy and return to duty. Pain and swelling of left leg on walking. Admitted February 23, 1943, over fourteen months after injury with diagnosis of arteriovenous fistula of femoral vessels. *A*, preoperative roentgenogram fourteen months after injury. Cardiac enlargement. *B*, postoperative roentgenogram, showing decrease of 2.3 cm. in transverse cardiac measurement. This case illustrates long time interval between injury and establishment of diagnosis of arteriovenous fistula. Reduction of 2.3 cm. in transverse cardiac diameter approximately three months after operation.

teriovenous communications must be considered, for they are usually chronic affections, often worrying little, but often subtracting days from the end of one's life.

Nicoladoni, in 1875, first observed a drop in pulse rate upon manual obliteration of an arteriovenous fistula,[4] and Branham, in 1890, independently observed slowing of the pulse following the same maneuver (Branham's sign). Stewart is credited by Dean and Dean[1] with being the first to call attention, in 1913, to the deleterious effect of arteriovenous fistula on the heart. Reid[20] showed that when fistulae were experimentally produced between the large vessels of the neck or legs, cardiac hypertrophy and dilatation would result, and in some cases, cardiac decompensation and death. Osler watched two patients, one for fifteen years and one for nineteen, who died at an early age as a result of cardiac decompensation associated with arteriovenous fistula. Matas, Leriche, Callender, Holman, and Reid have publicized the effect of arteriovenous aneurysms on the heart. Reid and McGuire[19] reported cardiac failure developing fifteen years after production of a fistula of the profunda femoris vessels. Mason[11,13] has reported cardiac decompensation occurring very early after establishment of the fistula.

Elkin has reported several cases with severe cardiac damage. He states the effect on the circulation as follows:[3]

> Establishment of a fistula [between artery and vein] introduces a secondary circuit into the vascular system. The peripheral resistance in this circuit is lowered, the capillary barrier being eliminated, and arterial blood is short-circuited directly from artery to vein. In a fistula of a large vessel, like the femoral, one-fifth to one-half of the blood ejected by the left ventricle is shunted to the right side. . . . In [most] instances, the blood pressure changes are not extreme, the systolic pressure soon returns to normal, but the diastolic pressure, as a reflection of the general lowering of the peripheral resistance, remains lowered. . . . The heart accommodates to the increased venous return by

acceleration of rate and increased strength of contraction, effecting an increase in cardiac output. Soon an increased circulating blood volume is added as another compensatory mechanism.

Holman[9] has shown in dogs the dilatation of the proximal artery and vein and the heart following establishment of a fistula between the aorta and vena cava. Autopsy showed a marked increase in the size of the cardiac chambers and in the thickness of their walls. He has also measured the proximal and distal vessels in patients with arteriovenous fistula, and has shown a definite enlargement of the proximal vessels.

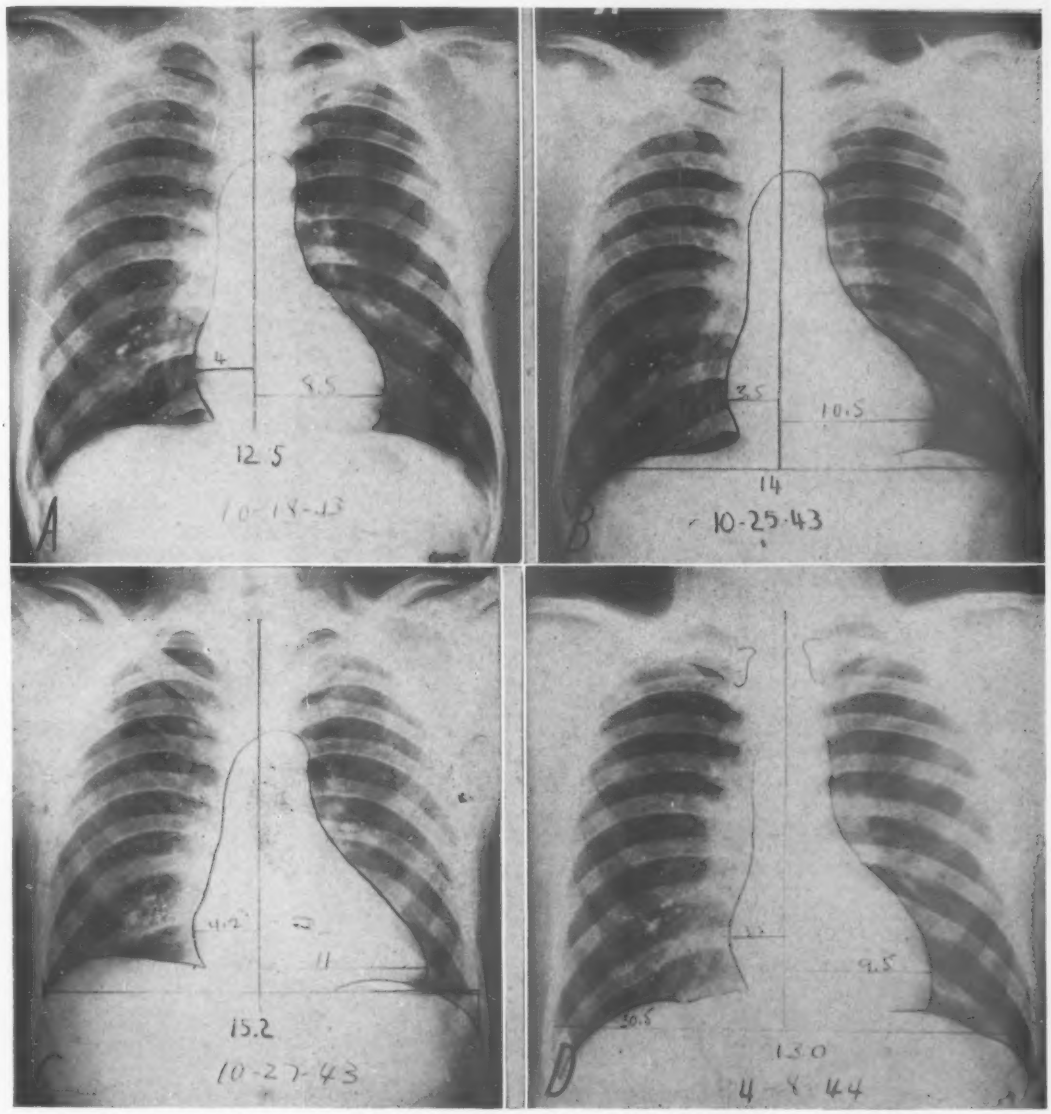
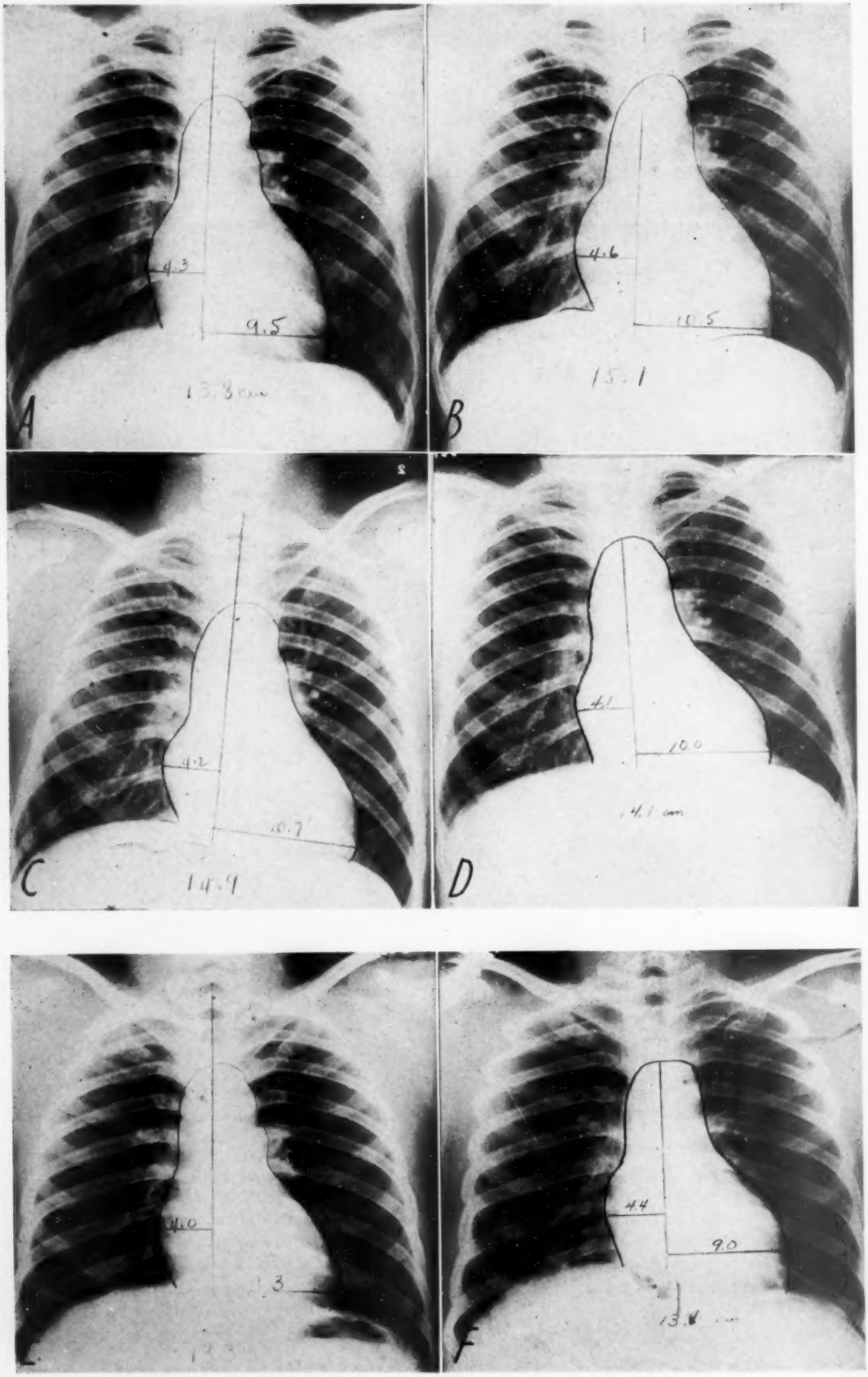


Fig. 2. Case 11. Shrapnel wound of right axilla October 15, 1943, resulting in arteriovenous aneurysm of right subclavian vessels. Resection of aneurysm November 24, 1943 (overseas). *A*, normal heart three days after injury. *B*, showing increase of 1.5 cm. in transverse cardiac diameter ten days after injury. *C*, showing increase of 2.7 cm. in transverse cardiac diameter twelve days after injury. Operation November 24, 1943. *D*, return to normal cardiac diameter four and one-half months after operation. This case illustrates early change in heart size after creation of arteriovenous fistula and subsequent return to normal size following operation.


4.3
9.5
13.8 cm
A
4.6
10.5
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B
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14.9
C
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10.0
14.1 cm
D
4.0
13
E
4.4
9.0
13.8 cm
F

McGuire and his associates[10] reviewed the clinical and experimental observations on the effects of arteriovenous fistulae in 1940. They demonstrated the following changes associated with the establishment of a large arteriovenous fistula: (*a*) fall in mean arterial blood pressure and acceleration of the pulse; (*b*) increase in cardiac output and stroke volume; (*c*) elevation of the venous pressure distal to the fistula, but little change in the venous pressure proximal to the fistula; (*d*) acceleration of the velocity of the blood flow proximal to the fistula. Retardation of the velocity of the flow distal to the fistula.

They questioned the rôle of increased blood volume in the production of heart failure, and attributed the increased blood volume to the increased capacity of the vascular bed in the collateral circulation.

Smith[25] studied the mechanics of the circulation in a patient with an arteriovenous aneurysm of six years' duration, before and after operation, and was able to demonstrate a reduction of 58 per cent in cardiac output, and an increase of 122 per cent in the coefficient of utilization following operation.

ROENTGENOLOGICAL STUDIES

The roentgenological studies incorporated in this paper have been directed at the investigation of:

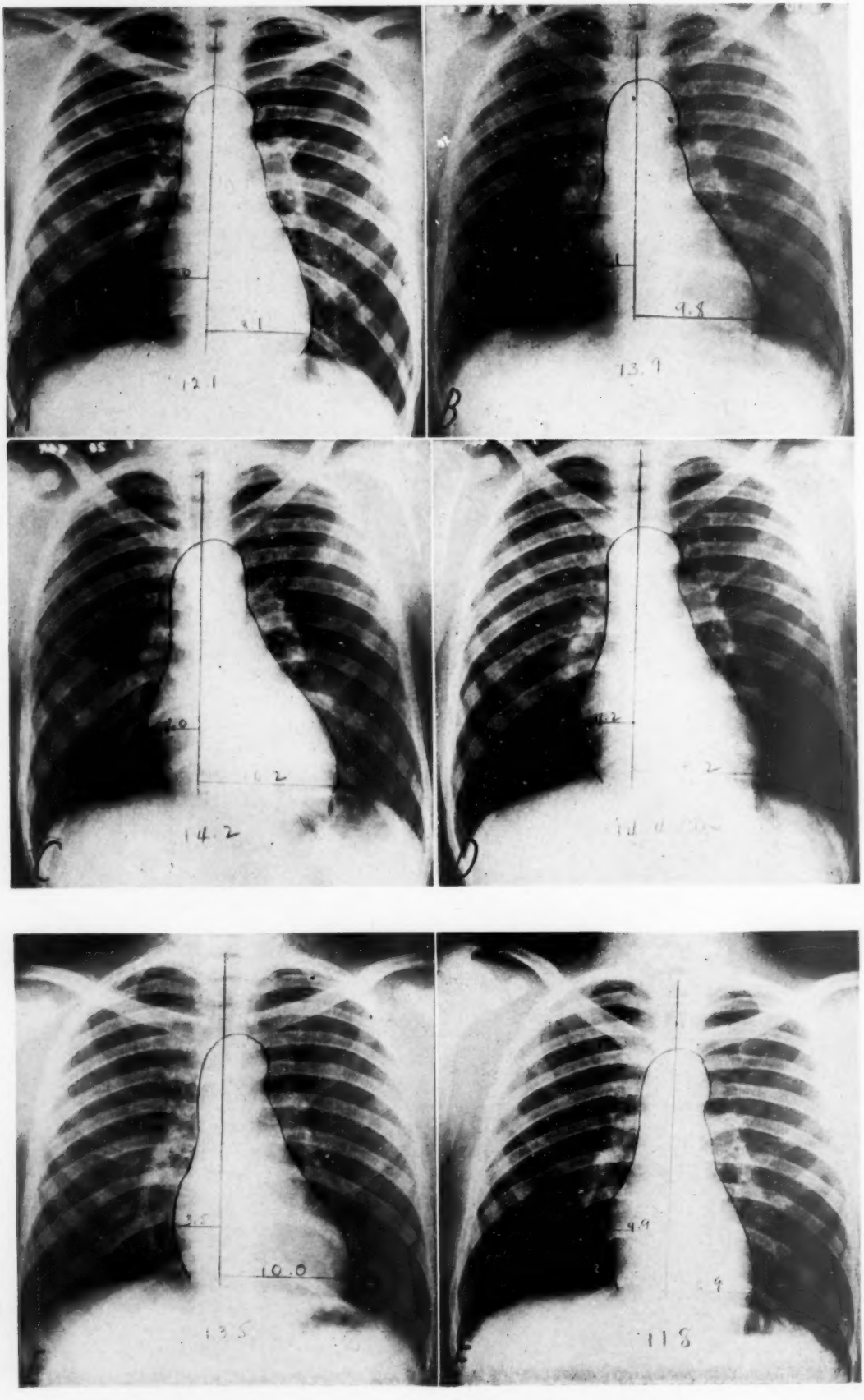
1. The detection of cardiac enlargement.
2. The effect of temporary manual obliteration of the fistula.
3. Study of the immediate postoperative changes.
4. Eventual changes in cardiac size following operative elimination of the fistula.

Method of Study. While practically all patients were studied roentgenoscopically, the measurement of cardiac size was based on the sum of the right and left transverse cardiac diameters on roentgenograms taken at 72 inches in full inspiration, using 150 ma., 1/10 second. Certain technical difficulties were encountered, but bedside roentgenograms were made in the erect position at 72 inches, and those showing more than 1 cm. difference in diaphragmatic level were discarded. All measurements were made by one observer. For various reasons, not all cases could be studied at the same time intervals; this explains the latitude in the interval studies after operation.

The changes in transverse cardiac diameter were, in many instances, very slight, but definite. Many of the patients examined had fistulae of relatively short duration, and extreme changes in cardiac size were not to be expected.

1. *The Detection of Cardiac Enlargement.* In most instances, previous chest roentgenograms were not available for comparison. Induction roentgenograms were obtained in a few instances, but the variability in size of films used at induction stations and in target film distances made measurement of induction roentgenograms impractical. We were able to observe definite increase in cardiac diameter when our roentgenograms were compared with transfer roentgenograms, in some cases, and one case showed definite increase in heart size during three weeks' observation in the hospital. The most striking fact evolving from studies on the existence of cardiac enlargement in arteriovenous fistula was that many cases showing normal cardiothoracic ratios and no abnormality of cardiac out-

Fig. 3. Case III. Shrapnel wound right thigh on June 13, 1944. Diagnosis of arteriovenous fistula of femoral vessels made five days after injury. Operation August 21, 1944. *A*, cardiac enlargement forty-six days after injury. *B*, increase of 1.3 cm. in transverse cardiac diameter in twenty-one days. *C*, two hours after operation. *D*, twenty-four hours after operation. Shows 1 cm. decrease in transverse cardiac diameter. *E*, forty-eight hours after operation; further decrease in heart size. *F*, seven days after operation; 1.7 cm. decrease in transverse cardiac diameter since operation. This case illustrates an increase of 1.3 cm. in transverse cardiac diameter in twenty-one days. Rapid decrease in cardiac size after operation without initial rise in first few hours after operation. Decrease of 1.7 cm. in transverse cardiac diameter seven days after operation.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line exhibited a definite decrease in cardiac measurements after surgical elimination of the fistula. In other words, the cardiac enlargement was not evident when commonly accepted standards were applied, but only became evident when the postoperative were compared with the preoperative roentgenograms. This indicates that while the cardiac changes in arteriovenous fistula may be early and dramatic in some cases, they are late and insidious in others.

In patients having true or false arterial aneurysms, and cirsoid aneurysms, no cardiac changes were demonstrated on the roentgenograms.

Congestion of the pulmonary vessels was noted in a few instances and this improved after operation.

2. *Effect of Temporary Manual Obliteration of the Fistula.* Twenty-three cases were examined before and during manual obliteration of the fistula. Compression was applied until the bruit was obliterated and the pulse slowed. This was difficult to accomplish in some of the subclavian fistulae, but could usually be easily done in fistula of the vessels of the extremities.

Thirty-three per cent showed a slight increase in transverse cardiac measurements upon compression. This increase varied from 0.1 cm. to 1.1 cm., averaging 0.46 cm. Forty-five per cent showed a decrease in the cardiac diameter, varying from 0.1 cm. to 0.9 cm., averaging 0.4 cm. Twenty-one per cent showed no change on compression of the fistula. One case was examined with prolonged compression with the Matas clamp. There was an increase of 0.2 cm. at two minutes, and 0.6 cm. in five minutes after the fistula was occluded. It is probable that further studies with prolonged compression might give results different from those obtained by temporary compression.

From this limited study (24 cases) it must be concluded that there is no appreciable change in cardiac size resulting from temporary occlusion of the fistula. Roentgenoscopically, the heart could be seen to slow its rate and increase the amplitude of its contractions.

3. *Study of the Immediate Postoperative Changes in Cardiac Size.* Holman[9] has described the postoperative changes in the heart twenty-four hours after operation, and has made roentgenographic studies of hearts of dogs within fifteen minutes after production of arteriovenous fistula. The earliest postoperative roentgenographic examination of the heart in this series was made one hour after operation, and showed a decrease of 0.9 cm. in transverse cardiac diameter. Eleven patients were examined two hours after operation; 9 showed an average increase of 0.97 cm., and 2 an average decrease of 0.45 cm. Seventeen patients were examined twenty-four hours after operation; 12 showed an average decrease of 0.61 cm., and 5 an average increase of 1.18 cm. Eighteen patients were examined forty-eight hours after operation; 8 showed an average increase of 0.6 cm., and 10 showed an average decrease of 1.01 cm. Nine patients were examined seventy-two hours after operation; 2 showed an average increase of 0.3 cm., and 6 an average decrease of 0.88 cm. Fifteen patients were examined seven days after operation; 5 showed an increase of 0.68 cm., and 10 showed an average decrease of 1.15 cm.

FIG. 4. Case IV. Multiple wounds of lower extremities sustained on November 11, 1943. Fractured femur. In March, 1944, patient noticed "buzzing" sensation in right thigh and felt thrill. Diagnosis of arteriovenous aneurysm made, and fistula excised July 29, 1944. *A*, preoperative roentgenogram; apparently normal cardiac outline. *B*, increase of 1.8 cm. in transverse cardiac measurements three hours after operation. *C*, six hours after operation; further cardiac enlargement. *D*, twenty-four hours after operation; maximum cardiac enlargment. *E*, forty-eight hours after operation; beginning decrease in cardiac measurements. *F*, seventy-two hours after operation; cardiac measurements less than on preoperative roentgenogram. This case illustrates apparently normal cardiac measurements seven months after injury. Immediately after operation, there was enlargement of the cardiac silhouette, beginning at three hours and reaching a maximum at twenty-four hours, with decrease at forty-eight hours and return to less than original measurements at seventy-two hours after operation.

While there was considerable variation in the time of appearance and the extent of measurable increase and decrease of the transverse cardiac diameter in the above series, the tendency was toward an increase in the first two hours after operation, and beginning decrease at twenty-four hours, continued to the seventh day after operation.

Many factors are believed to contribute to the variation in cardiac size immediately following surgical closure of the fistula, but the following are probably the most important: the size and duration of the fistula; the proximity of the fistula to the heart; the degree of dilatation of the proximal vessels; and the extent to which the myocardium is able to respond to the sudden circulatory changes.

4. *Eventual Postoperative Changes.* Because the chief function of an Army hospital is to return soldiers to either full or limited duty as soon as possible, not all patients could be examined at the same postoperative intervals. Convalescent furloughs also prohibited a rigid follow-up schedule, and the existence of other injuries often necessitated discharge of patients from the service. However, a group of 32 patients were examined at intervals varying from fourteen days to six months after surgical elimination of the arteriovenous fistula. Twenty-seven patients (84.3 per cent) showed an average decrease in cardiac diameter of 1.18 cm.; 1 patient (3.3 per cent) showed an increase; and 4 patients (12.5 per cent) showed no change.

SUMMARY AND CONCLUSIONS

1. Arteriovenous fistula is a common vascular injury of modern warfare. Cardiac dilatation and hypertrophy, with eventual failure, may result from the establishment of such a fistula. The cardiac changes may be demonstrated roentgenographically. Roentgenologists should be familiar with this particular cardiac effect and suspect the presence of a fistula in patients with cardiac enlargement who have suffered penetrating wounds.

2. The cardiac changes in arteriovenous fistula are usually reversible by surgical elimination of the fistula. Temporary manual occlusion of the fistula produces no appreciable change in the cardiac silhouette, but further study is indicated as to the effect of prolonged compression.

3. The immediate postoperative effect is an increase in heart size, with a decrease beginning in twenty-four hours, more evident at forty-eight hours, and usually well established by the seventh postoperative day.

4. Thirty-two cases of arteriovenous fistula have been studied roentgenographically with respect to cardiac measurements before and after surgical elimination of the fistula.

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THE SIGNIFICANCE OF CALCIFICATION IN THE ASCENDING AORTA AS OBSERVED ROENTGENOLOGICALLY*

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A CONSTANT comparison of diagnoses arrived at clinically and roentgenologically with those reached pathologically not only serves to check the accuracy of methods and observers but occasionally suggests correlations not hitherto suspected. In weekly conferences of roentgenologic-pathologic correlation at City Hospital of Cleveland, the frequent association of calcification in the ascending aorta, as seen in the roentgenogram, and the pathologic diagnosis of syphilitic aortitis was noted and discussed. Consultation of standard textbooks and medical journals yielded little information on the subject. Repetition of the observation, however, both in roentgenologic-pathologic conferences and in current clinical cases, in which calcification in the ascending aorta was associated with serological evidence of syphilis, furthered the conviction that this combination of events is more than coincidental, and that the presence of calcification in the ascending aorta is a reliable roentgen sign of syphilitic aortitis.

Calcification may occur in any portion of the aorta. Roentgenologically it is most often seen in the aortic knob of older patients in whom it is a manifestation of arteriosclerosis. Calcification is frequently observed in the walls of aneurysms which are usually syphilitic in origin but may rarely be arteriosclerotic. The presence of calcium in aneurysms has no etiologic significance but is valuable in the differential diagnosis between tumors and aneurysms especially in the mediastinal region.

Calcification in the ascending aorta, however, has been misinterpreted or completely ignored. Many have considered it a manifestation of arteriosclerosis. Others have used it to measure the diameter of the ascending aorta. That it has diagnostic significance is scarcely appreciated. Except for Schatzki[13] who thinks that calcification in the ascending aorta is more indicative of syphilitic aortitis than against it, no direct evidence in favor of this view could be found in the literature.

METHOD

In order to substantiate this view the following investigation was undertaken. All pathologically proved cases of syphilitic aortitis were collected and those with roentgenograms of the chest kept for study. An equal number of autopsied cases of severe arteriosclerosis, also with chest roentgenograms, was used for comparison. Roentgenoscopic observations alone were not considered. Many of the roentgenograms in the series were not of optimum quality as a result of the grave illness of certain patients, the supine position in which some of the exposures were made, and such technical errors as motion, underexposure, and partial rotation of the patient. None of the cases of syphilitic aortitis, however, was discarded for these reasons. Since the group of arteriosclerotics was unlimited, those with inadequate roentgenograms were replaced. No special techniques to demonstrate the presence of calcification were used. All cases in which a pathologic diagnosis of aneurysm of the ascending aorta had been made were excluded

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from both groups since the significance of calcification in aneurysms of the ascending aorta is not part of the problem.

In addition to a study of the roentgenogram, such subsidiary data as age, sex, race, and the presence or absence of aortic insufficiency, and the type of Kline and Wassermann reactions of the blood and spinal fluid were collected from the clinical records. Heart weights and the presence of syphilitic stigmata were determined by examination of the autopsy protocols.

As a further control, all current clinical cases with calcified ascending aortas were investigated serologically and otherwise for evidence of syphilis.

Fig. 1. Note linear calcification of ascending aorta (arrows). This is a routine posteroanterior roentgenogram of the chest. A dark print has purposely been made to show the calcium. Autopsy showed syphilitic aortitis.

SYPHILITIC AORTITIS

In all, 66 cases of pathologically proved syphilitic aortitis in which at least one roentgenogram of the chest had been made were studied. These were divided into two groups: those with calcification in the ascending aorta, the calcific group; and those without calcification in this region, the non-calcific group. This division depended entirely on the roentgen demonstration of calcium in the root of the aorta (Table 1).

The table shows that roentgenograms of 15 of the cases (22.7 per cent) revealed calcification in the ascending aorta. Thus, it is seen fairly frequently. When it is considered that the roentgen techniques used in the making of the roentgenograms were routine and that many of the roentgenograms were made under handicaps, the conclusion is justified that the figure 22.7 per cent is on the smaller rather than on the larger side. Furthermore, even if no special

Table I

SIXTY-SIX CASES OF SYPHILITIC AORTITIS PROVED AT AUTOPSY

	No.	Age	Sex	Color	Serology	Heart Weight	Clinical Aortic Insufficiency
Calcific Group (Calcium present in ascending aorta)	15	Av. 57	M 9	W 10	Pos. 9	359 gm.	Present 2
					Neg. 3		
		32–71 range	F 6	B 5	No record 3	230–550 range	Absent 13
Non-calcific Group (No calcium present in ascending aorta)	51	Av. 52	M 41	W 24	Pos. 40	483 gm.	Present 20
				B 26	Neg. 9		
		35–75 range	F 10	Y 1	No record 2	175–1200 range	Absent 31

FIG. 2. Extensive calcification of both walls of the ascending aorta.

effort is made to demonstrate the calcium, it can be observed and interpreted in approximately one-quarter of the autopsied cases.

The amount of calcium present varied from a thin linear plaque 1 to 2 cm. in length (Fig. 1) to extensive calcification of both walls of the ascending aorta (Fig. 2). The radiopaque shadows were most commonly seen in the right border of the ascending aorta halfway between the aortic valve and the beginning of the transverse portion. In occasional cases the calcification could be demonstrated only on one or the other of the oblique views.

Age. The average age of the patients in which calcium was present in the ascending aorta was fifty-seven years as compared to fifty-two years for those without calcification. It is presumed, therefore, that calcification occurs only when the luetic infection is of long duration and in those cases where the disease is less severe. Nevertheless, calcification was present in one patient, a Negro female, who was only thirty-two years of age (Fig. 3).

Sex and Color. Fifty males and 16 females were included in the syphilitic group. Calcification was present in the ascending aorta of 9 of the males and 6 of the females. Approximately 50 per cent of the patients were Negroes.

Serology. Positive serological tests for syphilis were found in blood, spinal fluid, or both, of 9 (60 per cent) of the 15 cases in which calcium was present in the ascending aorta. In the non-calcific group, serological tests were positive in a higher percentage (78.4) of the cases. These figures are in fair agreement with those of Lamb,[5] who found positive blood Wassermann reactions in 80 per cent of proved cases, and with those of Reid,[11] who found negative Wassermann reactions in 17 per cent shortly before death. These figures also reemphasize the fact that calcification occurs only when the luetic infection is of long duration and when serological evidence begins to disappear.

Aortic Insufficiency. Clinical evidence of aortic insufficiency was found in only 2 cases associated with calcium in the ascending portion of the aorta. As would be ex-

FIG. 3. Roentgenogram of the chest of colored female, aged thirty-two. Syphilis of the aorta. No evidence of aneurysm.

pected, the correct clinical diagnosis of syphilis of the aorta was made only in these 2 cases. This finding is in accord with the view of Levine[8] who has said that luetic aortitis may be "suspected if we find a positive Wassermann, but there are no signs that I know of that will tell you that luetic aortitis is present. In fact, luetic involvement of the aorta produces no physical disability until it does one of three things: produces an aneurysm and presses somewhere; closes the ostia of the coronary vessels, or produces aortic insufficiency."

These facts are highly significant. The clinical diagnosis of syphilis of the aorta is rarely made in the absence of aortic insufficiency and yet it appears that the proper diagnosis may be made from the roentgenogram alone in a certain group of cases, even though the aortic valve is competent. It is in this group that the "calcium sign" is most important since even the serological evidence may be non-contributory.

In the non-calcific group aortic insufficiency was present in 20 cases, or 39.2 per cent. Here again the correct clinical diagnosis was made when insufficiency was present. It was rarely made in the group in which the aortic valve was competent.

Heart Weight. The weights of the hearts in the calcific group averaged 359 gm., while those in the non-calcific group averaged 483 gm., a difference of 124 gm. The difference is undoubtedly due to the fact that many cases in the non-calcific group died of cardiac failure secondary to aortic insufficiency before calcium could develop in the aorta. It also implies that the "calcium sign" is a rather late finding in syphilis and may indicate quiescence of the lesion.

Table II

SIXTY-TWO CASES OF SEVERE ARTERIOSCLEROSIS OF THE THORACIC AORTA WITHOUT SYPHILITIC AORTITIS

	No.	Age	Sex	Color	Serology	Heart Weight	Aortic Insufficiency
Calcific Group (Arteriosclerosis with calcification of ascending aorta)	2	Av. 62.5 60–65 range	M 2 F 0	W 2 B 0	Pos. 1 Neg. 1	600 gm.	Present 1
Non-calcific Group (Arteriosclerosis without calcification of ascending aorta)	60	Av. 70 44–92 range	M 36 F 24	W 54 B 6	Pos. 6 Neg. 54	428 gm.	Present 0

ARTERIOSCLEROSIS

Arteriosclerosis is classified by the Department of Pathology at Cleveland City Hospital as severe, moderate and slight. Only the severe cases have been included in Table II. Sixty-two such cases were chosen with the following two provisions: (1) that the pathological description implied severe involvement in the proximal portions of the aorta, and (2) that a roentgenogram of the chest was available for review. It should be noted, however, that in many of the pathological descriptions of the aorta no specific mention was made as to the presence or exact localization of the calcification. These cases were also divided into calcific and non-calcific groups, again on the basis of the chest roentgenogram.

In only 2 cases (3.2 per cent) was calcium found in the ascending aorta. One of

these had a four plus Wassermann reaction on repeated occasions and in addition had obvious aortic insufficiency. Review of the available pathological material, however, did not permit a pathological diagnosis of luetic aortitis. The other patient had a negative blood Wassermann reaction and no other indications of syphilis. The remaining 60 cases showed no evidence of calcification of the ascending aorta that could be demonstrated on the chest roentgenograms. Their ages averaged seventy years, or thirteen years more than the average age of the calcific group of luetic aortitis. Calcification was frequently seen in the aortic knob but was not present in the ascending portion except as noted above. It appears, then, that age alone, even in the presence of severe arteriosclerosis, rarely leads to the deposition of roentgenologically demonstrable calcium in the ascending aorta. The blood Wassermann reaction was positive in 6 cases and negative in 54. The average heart weight was 428 gm.

CURRENT CLINICAL CASES OF SYPHILIS OF THE AORTA

To test the clinical applicability of the observation that calcification in the ascending aorta is a reliable sign of syphilitic aortitis, those cases which were observed clinically during the period of this study were investigated serologically for evidence of syphilis. Twenty such cases were collected.

As will be noted in Table III, the serologic tests for syphilis were positive in 13 of the cases, or 65 per cent. Aortic insufficiency was recorded in 5 cases. Other roentgen findings did not aid materially in the establishment of the diagnosis of luetic aortitis.

TABLE III

TWENTY CLINICAL CASES OF CALCIFICATION OF THE ASCENDING AORTA

Age	Sex	Color	Serology	Clinical Aortic Insufficiency
Av. 62	M 17 F 3	W 16	Pos. 13	5
45–74 range		B 4	Neg. 7	

Whether the 7 cases with calcification in the ascending aorta, but without positive serologic evidence of syphilis, represent syphilitic aortitis is, of course, unknown. It should be noted, however, that the average age of the entire clinical group is sixty-two years, whereas the average age of the autopsy group with syphilitic aortitis and calcification in the ascending aorta is fifty-seven years. Only 60 per cent of the patients in the latter group had serologic evidence of syphilis. The more advanced age of the clinical group may then account for the lack of confirmatory serologic evidence of syphilis in 7 cases.

DISCUSSION

The statistical evidence just presented is consistent with the known pathologic observations in syphilitic aortitis and intimal arteriosclerosis. The latter, as a general rule, shows its greatest manifestations in the abdominal portion, especially at or near the bifurcation. Unless the disease is marked, it is common to find that the proximal portion, often including the whole arch, may escape grossly visible disease. In contrast, syphilitic aortitis affects the proximal portion and is rarely observed beyond the isthmus or mid-thoracic region. As a rule, syphilitic aortitis is most evident in the ascending aorta, particularly near its point of origin. Calcification is not frequent in syphilitic aortitis but when it occurs it develops principally in the ascending aorta. As a general rule, when calcification occurs in syphilitic aortitis the disease is marked and advanced. Anatomically it is difficult to determine arrest or quiescence of the process.

The relationship between arteriosclerosis and syphilitic aortitis is an unsettled problem. Earlier observers considered them entirely separate entities which might occur coincidentally, especially in the older groups.[3,9] Arteriosclerosis was looked upon

as an obscuring factor in syphilitic aortitis. Some evidence that syphilis might predispose to arteriosclerosis has been submitted by Warthin[18] who showed that arteriosclerosis of smaller arteries is 25 times more common in syphilitics than among nonsyphilitics. However, conclusions about smaller arteries cannot be transferred to the aorta. Karsner,[4] in his discussion of the etiology of arteriosclerosis, believes that infectious diseases play an important rôle. Since syphilis is an infectious disease its relationship to arteriosclerosis may be inferred. Nevertheless, it is difficult to find in any of the available sources any direct connection between syphilis and arteriosclerosis. Most pathologists either consider calcification as a rare manifestation of syphilitic aortitis or the result of coincidental arteriosclerosis.

Whether the calcification found roentgenologically in the ascending aorta is the result of syphilitic aortitis or the sequel of an arteriosclerotic process initiated by syphilitic aortitis cannot be settled here. In either event the diagnosis of syphilitic aortitis can be made with acceptable accuracy if calcification is seen roentgenologically in the ascending aorta.

It should be mentioned with emphasis that calcifications in the aorta immediately above the sinuses of Valsalva or in the region of the obliterated ductus arteriosus are not considered since they are rarely demonstrated roentgenographically.

Most observers[1,12,15] have considered dilatation of the ascending aorta as the primary criterion for the diagnosis of syphilitic aortitis and considered calcification as evidence merely of arteriosclerosis. The dilatation, however, is of secondary moment when calcification is present. This is worthy of particular notice since dilatation may be confused with mere elongation of the aorta. Furthermore, moderate dilatation in the aged does not necessarily signify syphilitic aortitis. In the absence of calcification the other criteria,[2,6,7,10,16,17] which even in skilled hands are only moderately dependable, must be relied upon.

Many of the illustrations of syphilitic aortitis in the literature reveal calcification in the ascending aorta but its significance is not stated. Snellen[14] reported calcification in the ascending aorta in 7 of 8 patients who had clinical signs of aortitis but no conclusions as to its meaning are drawn. Unfortunately only an abstract of his paper was available. It is thus apparent that supporting evidence of the significance of calcification in the ascending aorta is present in the literature but that the correlation between it and syphilitic aortitis has been missed.

Since calcification is to be demonstrated, many may think that a heavy exposure using the Potter-Bucky diaphragm is the ideal technique. This, however, is erroneous since the walls of the aorta are in motion and slow exposures may obscure fine lines of calcification. Straight posteroanterior projections with rapid exposures are recommended. Any rotation toward the first oblique position may hide the right border of the ascending aorta behind the spine and adjacent structures. Confusing shadows which may be mistaken for aortic calcification are the angles of ribs, transverse processes of vertebrae, and calcifications in the bronchi. In confusing situations roentgenoscopy and oblique views are of great help. In occasional cases, one or the other of the oblique views may reveal calcification in the ascending aorta not otherwise apparent.

SUMMARY

The roentgenologic, pathologic and clinical findings of 66 autopsied cases of syphilitic aortitis have been reviewed. Linear calcification in the ascending portion of the aorta was present on the roentgenograms in 22.7 per cent. Comparison by roentgenologic methods has been made with 62 autopsied cases of severe arteriosclerosis of the aorta. Only 3.2 per cent in this group were found to have calcium deposits visible in the ascending aorta, on roentgenograms of the chest. The clinical findings in 20 current cases showing calcium in the ascending aorta have been presented.

CONCLUSIONS

1. Linear calcification in the ascending aorta is a valuable roentgen sign of syphilitic aortitis.

2. When calcification in this location is present its reliability may surpass that of negative serological evidence.

3. Calcification in the ascending aorta is not an early sign of luetic aortitis and occurs most often in older, relatively quiescent cases of syphilis.

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EGG-SHELL CALCIFICATIONS IN SILICOSIS*

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IN RECENT years there have appeared occasional reports describing peculiar annular densities in the chest roentgenograms of men afflicted with silicosis. These are generally seen clustered in the mediastinal region as fairly large spheroid nodules averaging 1 to 2 cm. in diameter, each with a sharply demarcated, apparently calcified periphery. This appearance of a thin casing around an ovoid body led to its apt designation as "egg-shell calcification."[9]

Sweany *et al.*[8,9] in 1936 expressed the belief that these shadows represented the result of collateral tuberculosis infection in cases of silicosis. This view was based primarily on the finding, in some silicotuberculous individuals, of suggestive caseation in the postmortem sections of such peripherally calcified hilar lymph glands. The authors stated that tuberculous activation, with caseation and subsequent calcification, would advance around the margins of the glands within which the older silicotic nodules had already been formed. However, Schulte and Husten[6] in 1936 showed cases of silicosis in which tuberculosis was first seen to develop, in their opinion, long after the known existence roentgenologically of these nodular opacities. In addition, some of their oblique views indicated that these shadows extended into the lung fields and were not limited to the hilar glands. They did not label them as calcifications but considered them to be dense silicotic connective tissue coats around bronchi and blood vessels, the cross sections of which would be projected as annular shadows on the roentgenogram. Lommel[2] in 1939 demonstrated the same lesions in many cases of silicosis which he found to be uncomplicated by tuberculosis, and he too described their presence in the parenchymal portions of the lungs. He held the view that they represented depositions of calcium in the inflammatory fibrous tissue around silicotic changes, whether in glands or in lung parenchyma. Davies[1] in 1939 found egg-shell or "mulberry" calcifications in great numbers among slate-quarry miners who had silicosis with or without tuberculosis. He did not, however, find them in silicotics from a neighboring coal-mining industry, even in those who had tuberculosis. Therefore he looked upon these shadows as being one peculiarity of silicosis resulting from slate-quarry mining. He made the additional observation that these lesions developed in some of the men years after they had left the mines and long before definite tuberculosis would ensue. As a result, he subscribed to the opinion that the lesions represented a degenerative process of calcification in dead or fibrotic tissue resulting from silicosis. With the aid of the tomograph, he arrived at the conclusion that they were present only in the mediastinum and not in the lung parenchyma.

In the absence of adequate postmortem studies it can readily be understood why there is such diversity of opinion regarding the nature and causation of these shadows. On the other hand, since the lesion is apparently not too uncommon, one would expect unanimity in roentgen descriptions of it, at least as regards its distribution. It is obvious that additional clinical and roentgenologic presentations are necessary if we are to develop a familiarization with and a better understanding of this rarely described roentgen finding. Four representative cases are herewith reported.

REPORTS OF CASES

CASE 1 (No. 18329). J. G., a white male, aged fifty-nine, was admitted to the clinic on

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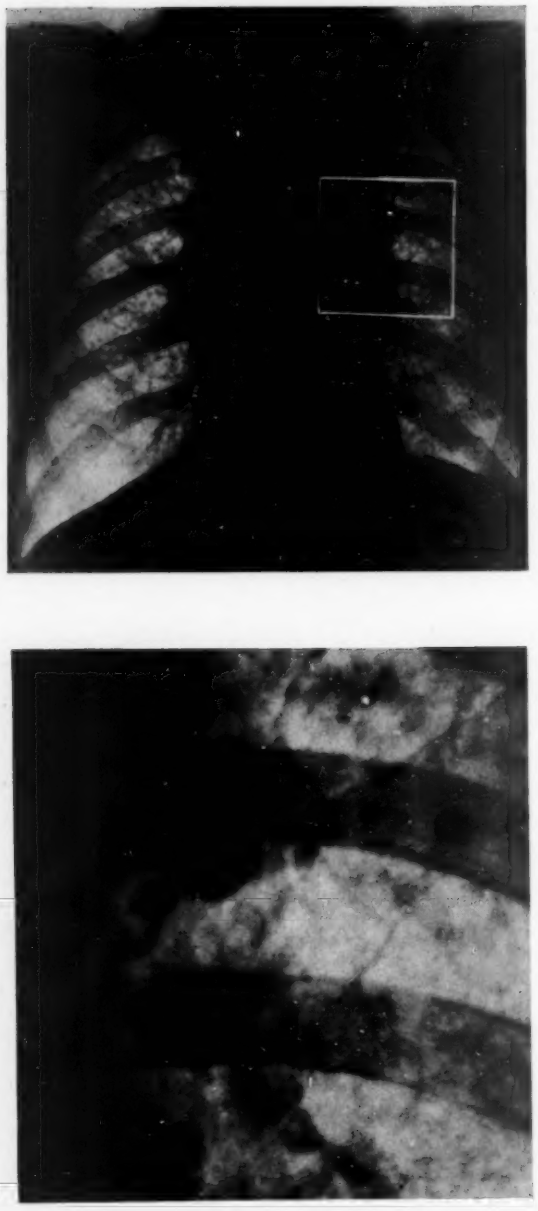


Fig. 1. Case I. Stone-cutter for forty years. Nodulation and fibrosis of silicosis exist throughout both lungs. Densely calcified nodules, typical Gohn tubercles, are evident in the left lower and mid-lung fields. The latter, at the level of the third rib anteriorly, is included in the squared area for comparison with the larger hilar nodes which have densest calcifications at their peripheries, the so-called "egg-shell calcifications." The enlargement of the squared area, in this and in the following cases, represents an actual size contact reproduction from the roentgenogram itself.

November 30, 1942, because a chest roentgenogram, taken as part of a routine physical examination, had resulted in a diagnosis of far-advanced pulmonary tuberculosis. A study of this patient revealed no complaints or history of dyspnea, cough, hemoptysis, chest pain, fever, fatigability or weight loss. He had, however, been occupied for forty years as a stone cutter, working with pneumatic hammers and grinding lathes on sandstone, marble, limestone and lava.

Physical examination of the chest revealed only diminished resonance to percussion over both mid-lung fields. Four direct smears, one concentrated specimen, and one guinea pig culture of sputum were negative for acid-fast bacilli. The intradermal test was positive, however, with 0.1 mg. old tuberculin.

The chest roentgenogram showed the characteristic nodulation and fibrosis of silicosis in both lungs. Densely calcified nodules, typical Gohn tubercles, were found in the left lower and mid-lung fields. Of particular interest were the larger nodes in the hilum with densest calcification at their peripheries, these being the "egg-shell" lesions of the present discussion (Fig. 1).

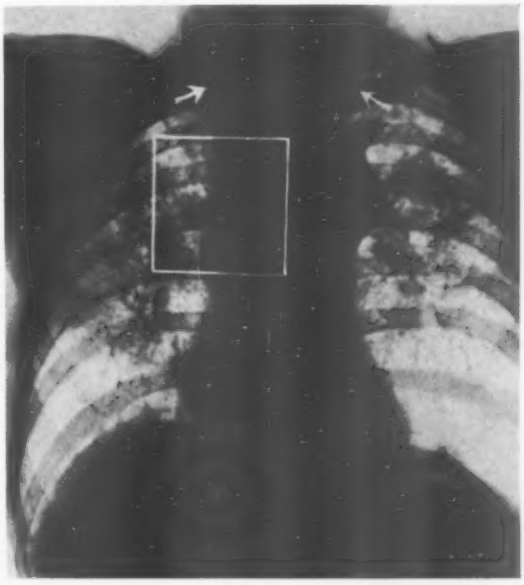
Case II (No. 18397). F. M., a white male, aged seventy-two, fellow-worker of Case I, was referred to the clinic by the latter on February 2, 1943, because of the progressive development of exertional dyspnea and hacking cough over a period of one year. He too had worked as a stone-cutter over a forty-two year period, thirty years by the side of Case I, with the same exposure to dusts of sandstone, marble, limestone and lava.

Physical examination of the chest revealed generally diminished expansion with slightly diminished resonance and scattered coarse moist râles over both upper lobes. Five direct smears and one concentrated specimen of sputum were negative for acid-fast bacilli. Intradermal test was negative with 0.1 and 1.0 mg. old tuberculin.

The roentgenogram of the chest showed bilateral fibrosis of well-advanced silicosis and, here also, egg-shell calcifications were found. In this case they appeared to extend from the hilum into the parenchyma of the right lung. Dense calcifications were also present in both apices (Fig. 2).

Case III (No. 18946). D. M., a white male, aged sixty, fellow-worker of Cases I and II, was

referred to the clinic by the latter men on May 24, 1944. He had been admitted to a tuberculosis hospital one year previously with fever, cough, chest pain and a roentgen interpretation



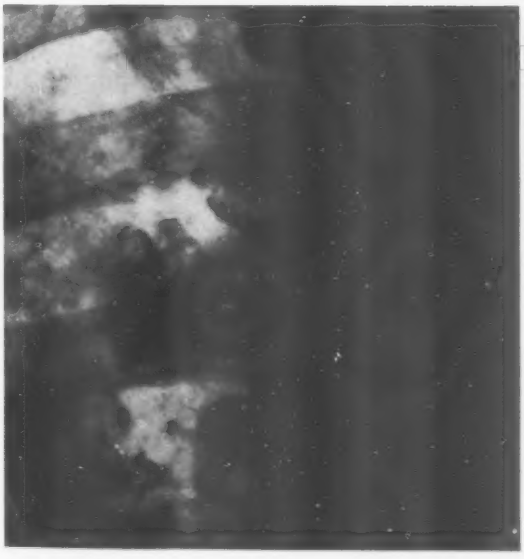
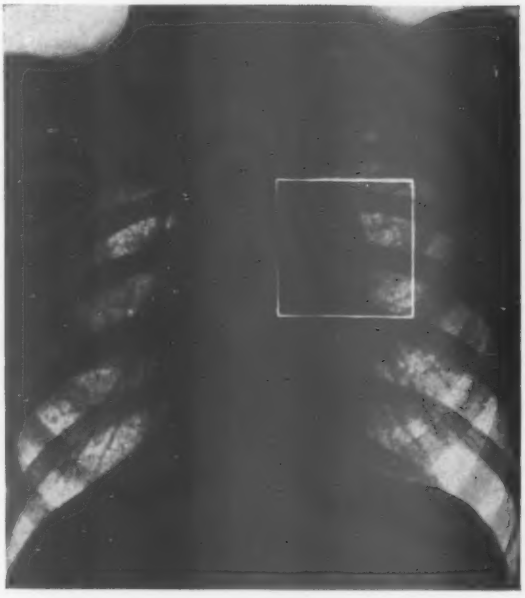


Fig. 2. Case II. Stone-cutter for forty-two years. Nodulation and fibrosis of silicosis are present in both lungs. Dense calcifications are evident in both apical areas. Egg-shell calcifications are most clearly manifest in the right hilum, but they exist also in the parenchyma of the right lung, especially between the second and third ribs anteriorly.



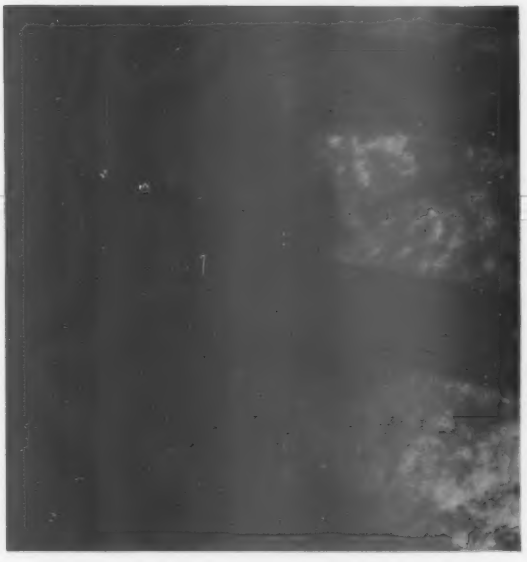


Fig. 3. Case III. Stone-cutter for forty-five years. Advanced nodulation and fibrosis of silicosis are evident in both lungs. There is an area of homogeneous density beneath the right clavicle. A Gohn tubercle exists in the left lower lung, and densely calcified nodules are found in both hila. Egg-shell calcifications are best seen in the left hilar area.

of active pulmonary tuberculosis. The symptoms disappeared after two weeks and never returned. During his stay in the sanatorium, sixteen direct smears and two cultures of

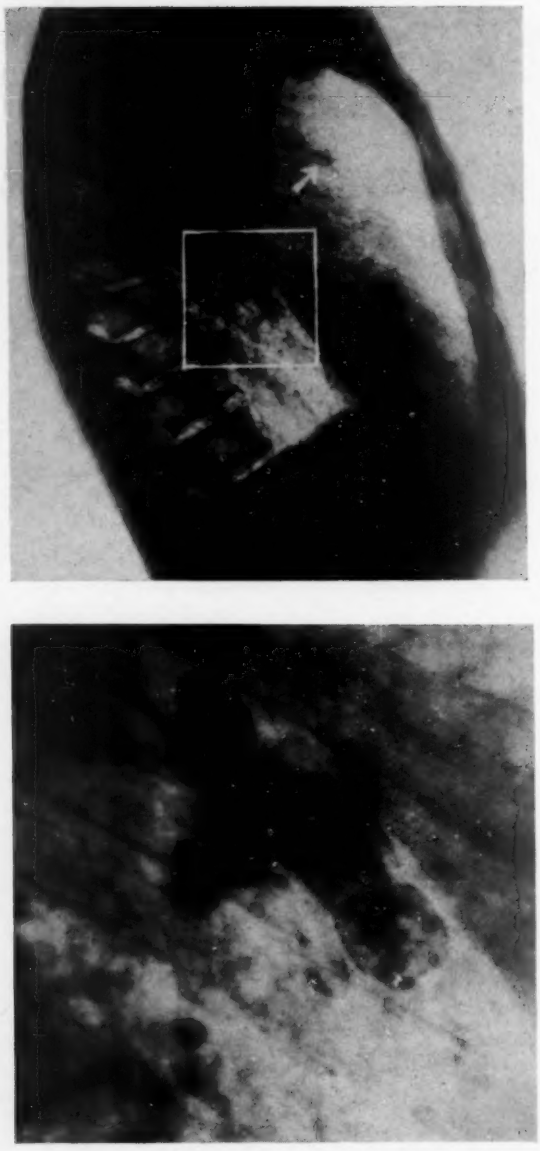


Fig. 4. Case III. Lateral view of same case as shown in Figure 3. This reveals the tendency of the egg-shell calcifications to assume a cluster formation in the hilar region. One egg-shell nodule is visible well away from the hilum.

sputum were negative for acid-fast bacilli. The Mantoux test was positive with 0.1 mg. old tuberculin. He was released from the hospital eleven months after admission with a discharge diagnosis of non-clinical silicotuberculosis. He, too, had been a stone-cutter for forty-five years, most of which time was spent by the side of Cases I and II with the same exposure to dusts of sandstone, marble, limestone and lava.

Physical examination of the chest on May, 24,1944, revealed only bilateral upper lobe dullness.

The chest roentgenogram taken three months after admission to the hospital is reproduced herein. It showed the nodulation and fibrosis of silicosis with an area of homogeneous density beneath the right clavicle. Here again were found some typical egg-shell calcifications in the hilar regions (Fig. 3). Their cluster formation was clearly manifested on lateral view, which also showed one such shadow well away from the hilum (Fig. 4).

Case IV (No. 17998). A. H. This patient, a white male, aged fifty-three, was admitted to the clinic on April 19, 1943, for follow-up study. He had just been discharged from a tuberculosis hospital where he had been admitted one year previously because of cough and a roentgen diagnosis of silicotuberculosis. In the hospital he had twenty-three direct smears and one guinea pig culture of sputum, all negative for acid-fast bacilli. No tuberculin test was made. He had worked as a hard-rock miner in various areas of Utah and Colorado from 1908 to 1931. His duties had consisted of digging and mill crushing for gold, copper, silver, lead and zinc.

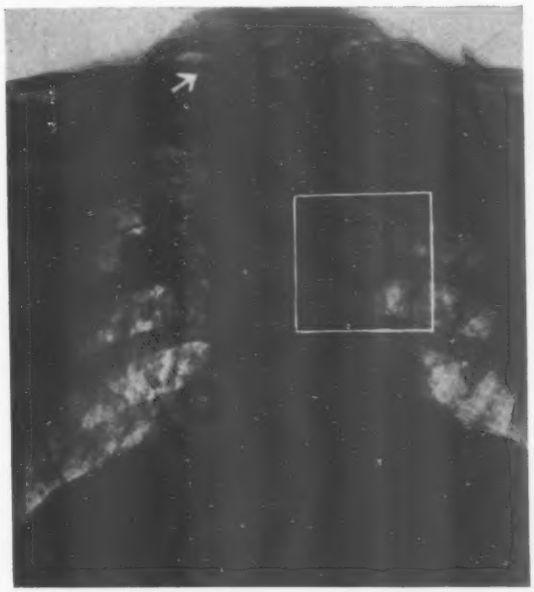
Physical examination of the chest on April 19, 1943, revealed markedly limited expansion of both lungs, diminished resonance and coarse moist râles over both upper halves of chest, and amphoric breathing beneath the left clavicle.

A roentgenogram of the chest showed the dense fibrosis of a far advanced silicosis in both lungs with an area of markedly increased density in the left upper lobe. Clearly defined egg-shell calcifications were again encountered, not only in the hila but also in the left lung parenchyma and in the extreme right apex (Fig. 5).

During his stay in the tuberculosis hospital a routine roentgenogram of the kidney, ureter and bladder had been made because of complaints referable to the genitourinary tract, and the same egg-shell nodules were found just below the left diaphragm near the spine (Fig. 6). These were evidently within the subdiaphragmatic lymph glands which received the drainage from the lung bases by way of the afferent lymphatics which traverse the crura of the diaphragm. Apparently these glands had been affected by the same inhalation process, and with the same result, as were those which were seen in the hila of the lungs.

DISCUSSION

The above data provide clear-cut examples of egg-shell calcifications in 4 patients with advanced silicosis. In none of the men



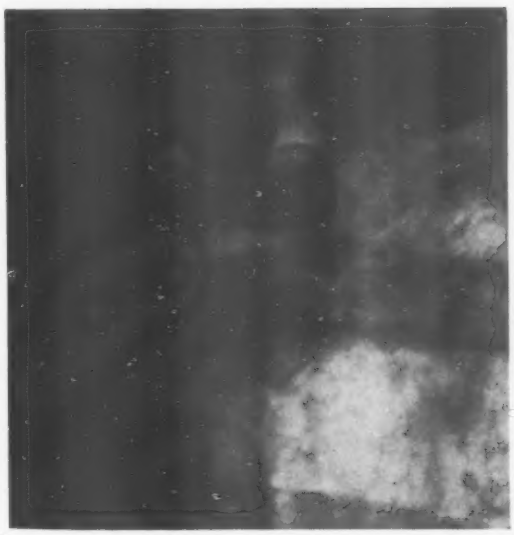


Fig. 5. Case IV. Hard-rock miner for twenty-three years. Dense fibrosis of silicosis is seen throughout both lungs. There is an area of increased density in the left upper lobe. Many small irregular calcifications exist in both lung parenchyma. Larger and more clearly defined calcifications of the egg-shell type are present in both hilar regions. They are also evident in the left perihilar region and in the extreme right apex.

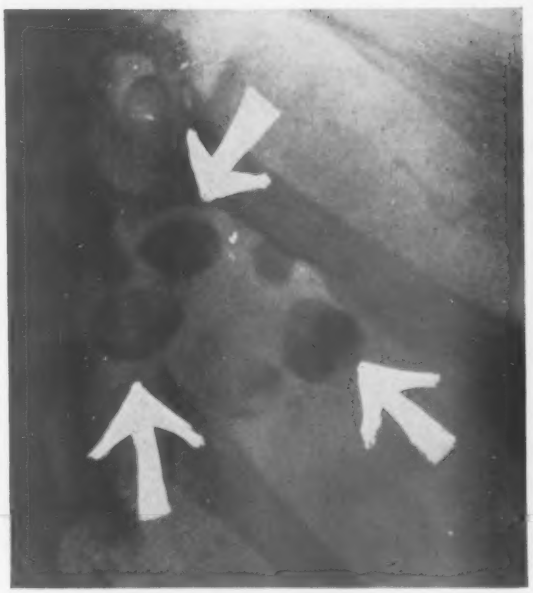


Fig. 6. Case IV. Roentgenogram of the abdomen of the same patient whose chest is shown in Figure 5. This reveals egg-shell nodules just below the left diaphragm near the spine. These are apparently within the pre-aortic lymph nodes which receive lymphatic drainage from the lung bases by way of the crura of the diaphragm.

was there any history or evidence of active pulmonary tuberculosis, although previous

primary infection could not be ruled out in all of them. Three of the cases give confirmation to the observations of Lommel[2] and of Schulte and Husten[6] that these shadows may exist within the pulmonary parenchyma as well as in the hilar glands.

As stated above, previous authors have variously theorized that the egg-shell lesions may be the calcified results of tuberculosis infection superadded to silicosis;[8,9] or merely silicotic densities which are not calcified;[6] or calcium degenerations in or around silicotic nodules.[1,2] To these a fourth viewpoint is herewith added, namely that the shadows may represent the results of direct inhalation of calcium along with the silica particles.

Although it is generally conceded that inhaled calcium is soluble in body fluids and is harmless to the lungs, several reports have been made which show that it can at least produce dense opacities in the pulmonary roentgenogram. Rest[4] has recently presented an interesting case with a temporary miliary mottling of the lung fields due to the inhalation of finely ground calcium carbonate. Rogers,[5] in his observations of silicosis among the marble workers of Vermont, found large numbers of calcified nodules in the hilum and scattered throughout the lungs. He attributed them to the inhalation of calcium dust. He did not, however, present any reproductions of roentgenograms of this finding. Siegal, Smith and Greenburg,[7] in their studies of tremolite talc miners, demonstrated large calcified plaques on the visceral pleura and suggested that they might have resulted from the deposition of inhaled calcium already present in the dust.

Lumsden and Dearing,[3] in an extensive tuberculosis survey, found pulmonary calcification on roentgen examination to be thirty to forty times as high in areas which had limestone and chert underlying the topsoil as in areas which lacked such soil. They also showed a lack of correlation between those calcifications and tuberculin sensitivity. Such importance of environment must be given consideration when analyzing Davies' finding of egg-shell calcifications among slate workers and not among coal miners; it is interesting to note that Davies found 1 per cent lime in his analysis of the slate dust.[1] Although no chemical analyses of the inhaled dust were made in the cases described in the present paper, there might be some significance in the fact that 3 of these 4 cases represented men who had worked side by side as stone-cutters for many years, with considerable exposure to the calcium dusts of marble and limestone as well as to that of sandstone.

Final conclusions cannot be drawn, however, from such considerations alone. Actually the exact nature of egg-shell calcifications could be determined only by extensive chemical and pathological studies which have never been made as yet. Meanwhile it will be necessary for the physician who may encounter such opacities to bear in mind all of the above discussed possible explanations for them. With him will rest the responsibility for making the important decision, in the case of a given patient, as to whether the shadows in question do or do not represent lesions of a complicating tuberculosis infection.

SUMMARY

(1) Four cases of silicosis with sharply demarcated annular densities in the roentgenograms of the chest, so-called "egg-shell calcifications," are herein presented and the roentgenograms reproduced.

(2) The few authors who have hitherto reported on such shadows have differed in their statements regarding the distribution of them in the pulmonary roentgenogram. Some have stated that they exist only in the hilar areas; others have described their presence in the lung parenchyma as well. The cases in this report appear to confirm the latter view.

(3) The previous authors have also differed in their interpretations of the cause of these shadows. They have variously labeled them as being (*a*) calcified tubercu-

lous lesions, (*b*) uncalcified silicotic densities, and (*c*) calcium degenerations in or around silicotic nodules.

(4) To these a fourth viewpoint is now added: that the densities under discussion may represent the results of inhalation of calcium along with the silica particles.

(5) In the absence of definite knowledge of the cause of egg-shell calcifications, the clinician and roentgenologist who encounter them are placed in the difficult position of deciding whether they represent a complicating tuberculosis infection or a less serious condition.

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CALCIFIED HEMANGIOMAS OF THE LIVER

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HEMANGIOMAS of the liver, among the most common benign tumors of the viscera, are rarely diagnosed prior to surgical or pathological discovery. They seldom become calcified and infrequently grow large enough to produce pressure symptoms. When symptoms of pressure or bleeding occur, other possible diagnoses are usually given first consideration.

The following case is of interest in that calcification, characteristic of hemangiomas as seen elsewhere in the body, was present in the liver and allowed a tentative diagnosis to be made.

REPORT OF CASE

The patient, housewife, white, aged sixty-eight, entered the hospital on February 12, 1944, with complaint of pain in the left lower chest and adjacent abdomen. Patient had had the "flu" during early part of December, 1943, and just prior to Christmas began to have pain of a sharp, burning or stabbing character, which was periodic in nature. A physician taped her chest but no relief was gained. During this time she began to perspire quite freely and her pain was so intense that she walked the floor at night in an effort to gain relief. On her admission to the hospital, the pain was of the same character and intensity, and even pressure of bed clothes added to her discomfort. The pain was localized low in the back and to the right of midline. Entrance temperature, 101° F., pulse 86 with occasional dropped beat, blood pressure 190/112, respiration 20 and regular, height 5 feet, weight 100 pounds. Physical examination was negative except for the abdomen. The liver was questionably palpable. Tenderness was found along the distribution of the lower left thoracic intercostal nerves and in the upper abdomen. Tenderness of the costovertebral angle was evident on the left. Reflexes were physiological with adequate circulation.

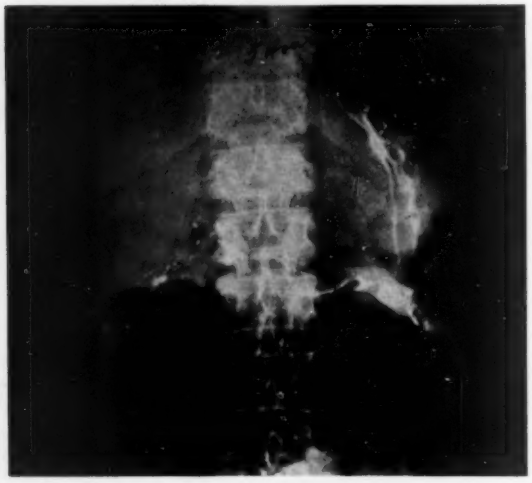

FIG. 1. Appearance of hemangiomas at gastrointestinal examination.

Past History. Patient was a para VI, gravida VI. She passed through the menopause in 1928 and since then has had no bleeding or discharge. Since about the middle of 1942, she began to note swelling of the feet and ankles towards the end of the day, which receded after a night's sleep. No dyspnea.

Urine was essentially negative except for 15 to 20 blood cells. Complete blood count taken on February 13 showed: erythrocytes, 4,310,000; hemoglobin, 83 per cent, 12.5 gm.; leukocytes, 14,400; granulocytes, 87 per cent; small lymphocytes, 12 per cent; large lymphocytes, 0; monocytes, 1 per cent.

Roentgen examination of the thoracic spine on February 14, 1944, revealed osteoarthritic changes in the thoracic spine with sclerosis of the aorta. On February 17, roentgen examination of the stomach revealed no pathologic condition of the heart, lungs, stomach or duodenum. There were, however, extensive circumscribed calcified shadows in the region of the liver (Fig. 1) in which streaks of calcification seemed to radiate out from the center. The impression at this time was that of benign neoplastic involvement of the liver, possibly hemangiomas.

The patient's course in the hospital was uneventful, other than her temperature, which was spiking in character, in which the highest was 101° F. On February 23 she had a chill and her temperature went up to 103.8° F. The stools, during the hospital stay, were always of a brownish color. On February 14, a sedimentation rate was done, which in fifteen minutes was

16 mm. and forty-five minutes, 53 mm., and on February 24, a catheterized urine specimen showed 2 to 3 pus cells, and 2 plus albumin.

The patient was discharged home on February 26, 1944, and at that time still complained of pain in her lower left side.

She was readmitted on March 12, 1944, with same history, except that the pain had become more diffusely spread over into the right upper abdomen.

Physical Findings. Blood pressure, 140/96; temperature, 101.4° F.; pulse, 90; respirations, 38; heart and lungs, negative.

Abdominal Examination. Liver was not palpable as on previous examination. Some tenderness was evident in both costovertebral angles. Abdomen was negative for masses and only voluntary muscle guarding was present in the upper abdomen. A slight amount of tenderness was found.

Urine specimen on March 13 was pinkish in color, negative for occult blood with occasional pus cells.

On March 15, 1944, at 6:05, patient called the nurse because of sudden onset of pain in the right upper abdomen and vomited approximately a cupful of bright red blood. The patient was extremely pale, lips cyanotic, radial pulse weak, respirations slow. At 6:42 the patient died.

Postmortem examination by Dr. Robert Stier revealed the cause of death to be a ruptured dissecting aneurysm of the aorta just above the diaphragm. Multiple cavernous hemangiomas were found in the liver.

The principal autopsy findings in detail were:

(1) An enlarged, irregularly outlined liver that extended approximately 6 cm. below the ribs in the midaxillary line. The right lobe of the liver had a mottled and dark purple color. The central portion of this lobe was replaced by one slightly raised nodular area of dark purple color. Many smaller diffuse areas were found beneath the capsule and were irregularly scattered within both lobes. The largest nodule measured 12 by 6 cm. and the smallest measured 5 cm. in diameter. These masses were quite sharply demarcated from a comparatively normal appearing liver parenchyma. None of the major blood vessels was involved by the above mentioned tumor masses. The nodules cut with little resistance, but within the masses, particularly the largest mass, some pin point areas were encountered that cut with bone-like resistance (Fig. 2 and 3).

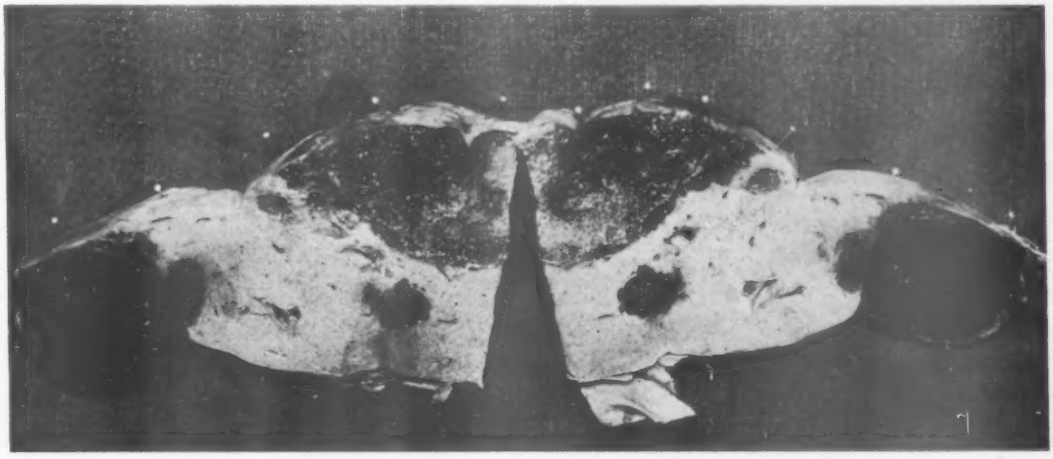

Fig. 2. Gross specimen at autopsy.

Other abdominal organs showed no remarkable changes.

(2) Within the chest cavity the lower segment of the thoracic aorta showed a fusiform dilatation that had ruptured and the right thoracic cavity contained coagulated blood. The lower right lung was attached to the aneurysm and the adjacent lung tissues were hemorrhagic. The lungs otherwise except for emphysema and congestion showed nothing remarkable. The heart was unaltered. The aorta showed calcified plaques, more numerous as the thoracic portion and aneurysm were reached.

On microscopical examination (Fig. 4 and 5), the tumor masses of the liver were seen to be

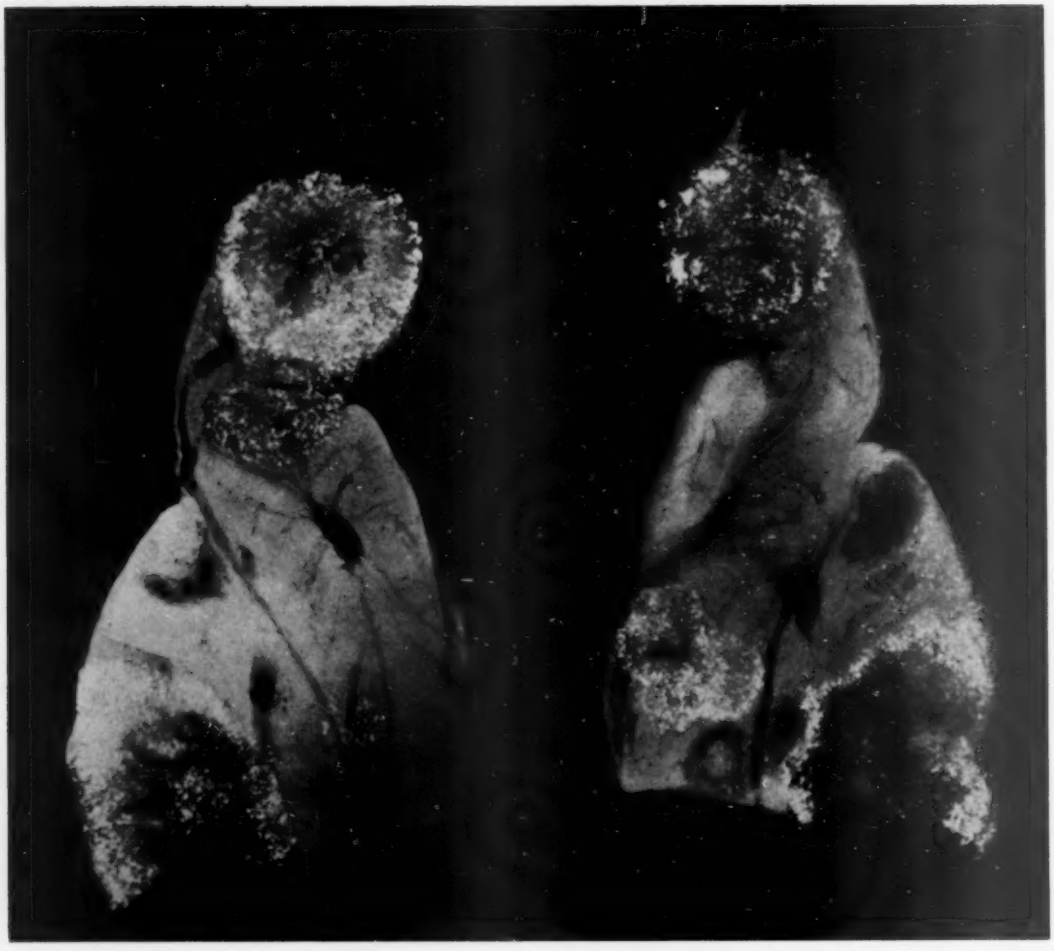

Fig. 3. Roentgen examination of specimen.

made up of cavernous sinuses that occasionally showed obliteration by hyalinized connective tissue in which some deposits of calcium salts were noted. The tumor masses were not encapsulated and some isolated blood sinuses were found in the surrounding liver parenchyma. The sinuses were lined by single rows of uniformly equal endothelial cells and in none of the sections was there any evidence of activity among these lining cells. The liver cells showed autolysis and atrophy. Numerous deposits of normal appearing fat were noted, both extra- and intracellularly. The lungs in the region of the ruptured aneurysm showed marked infiltration by autolyzed red blood cells. Apparently no hemangiomas were present here.

Angiomas of the liver are practically always of the cavernous type. According to Geschickter and Keasbey,[15] blood vessel tumors are perhaps as common as any form of neoplasm occurring in the body, and an extremely large number (109 out of 570 tumors of this type listed at the Johns Hopkins Hospital) occurred in the liver. The majority of these tumors were small, 0.5 to 5 cm. in diameter, and were accidentally discovered at autopsy. Occasionally they grow to such size that they become clinical problems by producing pressure symptoms. The usual diagnoses in these instances are cyst or neoplasm of the pancreas, cyst of the omentum or mesentery, or metastatic carcinoma of the liver. In one instance the tumor grew so large that it weighed 18,160 grams, or 39.6

pounds, at autopsy (Ray).[38] Angiomas occasionally bleed following trauma. Kissinger[25] reported a case of an infant with death from rupture of a cavernous hemangioma following a difficult labor.

The roentgen appearance of calcified hemangiomas was recognized by Ruggles[40] in 1919 following examination of an obvious angioma in the soft tissues of the jaw. Prior to this (1916, American Atlas of Stereoroentgenology) he had reported a case of undiagnosed soft tissue calcification in the forearm. These occurred as numerous calcified masses varying in size from 1 to 10 mm., without definite reference to the structures of the arm. Some of the large ones showed a cyst-like structure with a calcified nucleus. When the nature of these various calcifications became evident, Ruggles predicted their recognition in liver and intestines.

Carman,[8] in 1921, observed a polypoid mass in the duodenum without calcification, which on operation was found to be a hemangioma. His examination of the literature at this time revealed a case reported by Winternitz and Boggs[51] in 1910, detailing the necropsy findings of multiple hemangio-endotheliomas throughout the

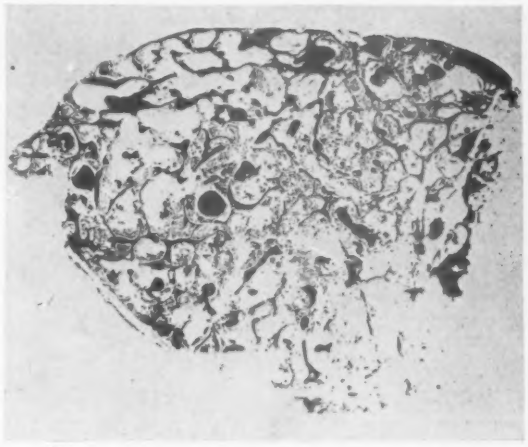

Fig. 4. Low power photomicrograph.

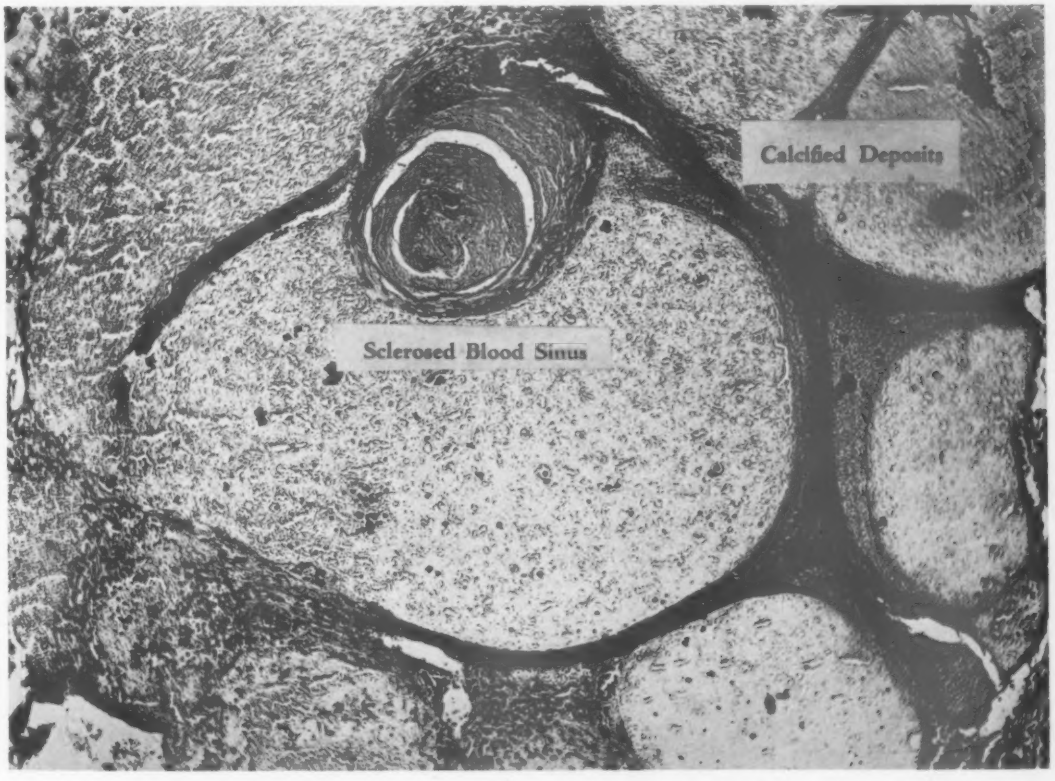

Fig. 5. High power photomicrograph.

alimentary tract. In 1924 Moore[29] reported 23 cases of benign tumors of the stomach, 5 of which were hemangiomas. No diagnostic findings were observed which would serve to differentiate hemangiomas from other benign tumors. Several of the hemangiomas were reported as carcinoma of the stomach. Hemangiomas of the kidneys have occasionally been reported (MacKenzie and Hawthorne[27]), and in none of these cases has calcification been present to allow a preoperative diagnosis; nor has there been anything in the history, symptoms or findings that would make a positive diagnosis of angiomata possible.

In 1930 Bucy and Capp[6] gave a complete description of hemangiomas occurring in bone. According to them, the appearance of hemangioma cavernosum of a flat bone is characteristic of the lesion. There are strikingly large, numerous "sunburst" trabeculations arising and radiating out from a common center. In some of the cases the trabeculations have the appearance of fine bone spicules. These writers made the lucid observation that the changes in bone, i.e., destruction and spiculization, are merely the reaction of the bone to the hemangiomatous growth. To illustrate the point, a case is described of a hemangioma arising in the meninges and invading the parietal bone. Microscopically, however, the same osseous changes of absorption and osteogenesis can be seen as in cases of true hemangiomas of bone. This would seem to indicate that these changes are the result of the ingrowth of the hemangioma into the bone regardless of its origin, and that they are not characteristic of hemangiomas arising in bone. The radiating calcification of the hemangioma of the liver found in this case further substantiates this point. The same tendency was strikingly brought out by Schwartz[44] in 1939, and it was his description of hemangiomas of the skull that led me to the belief that the liver lesion might be due to benign tumors of this type.

Ponzio[34] in 1932 observed numerous mulberry-shaped calcium shadows, up to the size of chick-peas, in the regions of the liver and spleen and concluded that these shadows were calcified hemangiomas or lymphangiomas. The diagnosis was made because of the similarity of the calcified shadows to those described by Ruggles in in angiomas elsewhere, but confirmation is, unfortunately, lacking.

In the differential diagnosis of calcification in the liver, gummata, hydatid cysts, tuberculomas, amebic abscesses, intrahepatic calculi, calcified primary and metastatic carcinomas and calcified subphrenic abscesses have been considered. In most of these, the character and location of the calcification serve to differentiate them from hemangiomas.

Gummas, as a rule, do not exhibit calcification. Henke and Lubarsch, however (Gray[17]), stated that calcium may be deposited in these lesions. The lesions would probably be of long duration and evidence of syphilis should be present elsewhere in the body. The calcification, although it may be trabecular in type, would probably not exhibit the radiating tendency seen in hemangiomas.

In echinococcus cyst, the masses are usually in the form of mild, negative shadows because of the greater roentgen permeability of the cysts as compared to the surrounding structures. The masses may have the same density as the liver. The shadow is usually rounded and if located near the superior or posterior aspect of the liver it may be demonstrated by simple roentgen examination. If the cysts become infected or ruptured, they may contain air with a fluid level.[3,16,21,34,35] In chronic cases, calcification may occur which usually assumes a shell-like area with calcareous concentric strips alternating with transparent ones (Cottone[9]).

Calcified tuberculomas differ in their structural characteristics. The appearance varies with the age of the lesion and early there is calcification of the capsule surrounding the central core (Sweany[46]). Later on, there is the appearance of a sphere with a central density having a surrounding moat. The size may reach that of a marble

(smaller than the hemangiomata seen here) and there is usually evidence of tuberculosis elsewhere in the form of calcified glands or an active lesion.

The acute amebic abscesses give a clinical picture similar to subphrenic and intrahepatic abscesses without the presence of calcification. In the chronic cases, calcification occurs in the form of dense irregular shadows which are quite different from those seen in hemangioma. In these cases, there has practically always been a history of amebic dysentery (Santoro[42]; Dickinson[10]).

Single or multiple intrahepatic calculi are exceedingly rare. The appearance as described by Volpe[49] is that of a mulberry-like shadow in the region of the liver. Calcified subphrenic abscesses can be differentiated easily by location. Calcified primary carcinoma has been reported by Hamburger[19] occurring in a five year old child. He ascribed the calcification to irradiation of the tumor. In his article he states that calcification may also occur in the liver in the later stages of infective granuloma, general metabolic diseases (chronic kidney diseases or conditions resulting in the destruction of bone) eclampsia and diabetes. Calcified metastatic carcinoma is rarely seen, although, because of the marked influence of various endocrine agents, we may see calcified metastases more commonly in the future. The clinical picture should serve to differentiate these conditions.

The treatment of hemangiomas is either by surgery, radiation therapy or a combination of these two. Surgical procedures are simplified if the growths have a pedicle (Morris,[30] Peck,[33] Morton,[31] Shumacker[45]). Serious complications, such as fatal hemorrhage, have occurred due to rupture prior to or at laparotomy. The excision must be made wide of the growth as hemorrhage, even from a needle prick, may be uncontrollable (Tinker[47]). Tinker states that in the light of newer surgical methods, particularly electrosurgery, surgeons could be bolder in attacking hepatic tumors. In the field of radiation therapy, Ray[38] described his successful results in an inoperable case. A large spheroidal, inoperable hemangioma was found deeply embedded in liver substance. Four Cushing silver clips were pressed into the liver substance at intervals about the margin of the tumor. A course of roentgen therapy was instituted shortly afterwards, alternating anterior and posterior fields with average dosages of 300 to 370 roentgens. Over a period of four months 5,772 r was administered and the series was repeated to 4,602 r after an interval of four months. Observation indicates an absence of symptoms since treatment and successive roentgenograms of the abdomen have revealed a marked and progressive diminution in the size of the tumor. This has continued three to five years after cessation of all treatment. Morris[30] gave irradiation to hemangiomas of the liver in a case in which he had successfully removed the major hemangioma. One month after operation a mass the size of a fist was found over the right lobe and it was thought that this represented active growths of hemangiomas noted on the right dome of the liver at the time of operation. Eight treatments of $\frac{1}{3}$ erythema dose were given during the next month, and when last seen three years later, no masses were palpable and the patient was symptom free. These two experiences, in view of the known response of hemangioma to irradiation elsewhere in the body, would indicate that radiation therapy offers a valuable adjunct to treatment, particularly in the inoperable cases.

SUMMARY

The tendency towards radiation of calcified spicules from a central point which is seen in hemangioma of flat bones (Bucy and Capp) is also seen in this case of hemangiomas of the liver. This may prove to be characteristic of calcification in visceral hemangiomas. Radiation therapy is indicated in certain of these lesions.

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ROENTGEN DEMONSTRATION OF THE SEMILUNAR CARTILAGES OF THE KNEE

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INTRODUCTION

THE purpose of this paper is to present a roentgen technique for the demonstration of the semilunar cartilages of the knee joint. The method to be described results in an adequate visualization of injuries of these cartilages and materially aids in their correct diagnosis and treatment.

In the clinical examination of the knee for suspected injury to the menisci the usual roentgen studies have been made either to rule out pathologic conditions which might give rise to symptoms similar to those of cartilage injuries or for their negative value.[15,16,17] On these roentgenograms of the knee the semilunar cartilages are not visualized except in those instances in which (1) the cartilages are calcified,[3] or when (2) air is present in the knee joint spontaneously.[8,12,14] Both of these findings are unusual. We have seen one case of a calcified lateral meniscus and several instances of the spontaneous presence of air in the knee joint.

The following roentgen signs have been suggested as being indicative of injuries to the semilunar cartilages:

(1) Narrowing of the joint space on the side of the injured cartilage.

(2) Slight lateral displacement of the femoral condyle on the side of the injury.

(3) A localized sclerosis of the tibial tuberosity just beneath the involved cartilage in comparison to the normal.[8]

None of these signs, however, have been proved to be of sufficient accuracy to be of value in the diagnosis.[13]

In order to visualize the menisci roentgenographically, contrast media, radiolucent (gas, usually air) or opaque (iopax, sodium iodide), singly or in combination, have been injected into the knee joint.[1,4,6,10,18,21,22] In addition, the cartilages have been demonstrated without the aid of contrast media by forced abduction of the knee joint.[7,8,9,20] In one series of normal knees,[20] the medial meniscus was visualized in 70 per cent of the cases. However, the lateral meniscus was only visualized in 2 out of 30 cases.

By combining the injection of a small amount of air with forced abduction of the knee joint during roentgenography, we have been able to visualize both semilunar cartilages satisfactorily.

TECHNIQUE

1. *Injection of Air into Joint.* The entire examination is conducted in the roentgenographic room. No special preparation has been employed. Most of our patients have had the examination directly after reporting to the roentgen room from their usual duties. The patient is placed on the roentgenographic table in the supine position with his legs hanging down over one end of the table. The skin over the lateral aspect of the knee joint is surgically prepared. The site chosen for injection is just lateral to the patellar ligament at the knee joint through the ligamentum mucosum.[22] The skin and superficial subcutaneous tissues are infiltrated with 1 per cent novocain. The anesthesia is purposely not carried down to the joint capsule, because when the joint capsule is pierced, the patient experiences a sudden, momentary pain which we have used as an indication that the needle is in

the joint space. (In the last group of cases, novocain has not been employed. It is planned to discontinue its use in order to simplify the technique and eliminate possible sources of reaction and contamination.)

A No. 20 gauge needle attached to a 30 cc. syringe is used to enter the joint. If fluid is present, *as much as possible is aspirated.* This is facilitated by pressure on the suprapatellar pouch. After the fluid is aspirated, 10 to 20 cc. of atmospheric air (depending on the size of the knee joint), filtered through several thicknesses of sterile gauze, is slowly injected into the joint. *If the needle is in the joint, the air can be injected with very light pressure on the piston of the syringe.* If greater pressure is necessary, it means the needle is not in the free joint space. While the air is being injected, the suprapatellar pouch may be seen to bulge slightly along the medial aspect of the joint, but this may not occur in knees with large joint spaces. After the air is injected, the needle is withdrawn and the puncture wound sealed with collodion. In none of our cases has there been any extra-articular leakage of air as far as we could determine from the roentgenograms or by clinical examination.

2. *Accessories Needed for the Technique Used.* In order to carry out the technique of roentgenography about to be described, we have had to construct two simple additions to our roentgenographic equipment.

a. A device for immobilizing the knee joint while lateral traction is exerted on the leg and thigh. We have used an |___ shaped piece of wood constructed of 2 by 4 inch lumber. The vertical portion of this device is 6 inches high. A 5 inch roller bandage about 2 inches in diameter is fastened to the external surface of this vertical piece by means of gauze and adhesive. The free end of the horizontal piece must be constructed so that it can be secured to one side of the table. This will vary with tables of different types. The length of the entire bar with the roller bandage is such that when the device is fastened to the side of the table and a knee placed against the roller bandage, the knee will automatically be centered on the table (Fig. 1*a*).

b. A device for exerting lateral traction on the thigh. This was made from unbleached muslin (three thicknesses) 60 inches long and 8 inches wide, one end of which was made into a loop 12 inches in diameter. The other end of this muslin band was so altered that it could be incorporated into the mechanical portion of the compression band device, which is present on most roentgenographic tables (Fig. 1*b*).

3. *Technique of Manipulation and Roentgenography, Including the Effect of Fluid.* After the air is injected, the patient is placed in the prone position on the table. The looped end of the muslin band is slipped over the foot and leg on to the thigh. The |___ shaped piece of wood is fastened to the side of the table and the knee joint placed against the roller bandage. The free end of the muslin band is incorporated into the mechanical portion of the compression device and then is tightened so that lateral traction is exerted on the thigh to the limit of the patient's tolerance. Manual traction on the leg is produced by hand, again to the limit of the patient's tolerance (Fig. 1*c*).

By the maneuver outlined above one compartment of the knee joint is "opened up" and a "condition of pressure" is produced therein which seems to "suck" the air previously injected into the joint to the side being forcibly abducted. By making the roentgen exposure while this lateral traction is being performed, the semilunar cartilage on this side of the joint is visualized. To visualize the cartilage in the other compartment of the knee, the traction and knee immobilizing devices are switched to the opposite side of the table and the same procedure as outlined above is repeated.

Both compartments of the knee joint, medial and lateral, are examined in the prone and supine positions. Since air will rise to the highest level, by roentgenograph-

ing each compartment of the joint in both positions, the anterior horn (when the patient is supine) and the posterior horn (when the patient is prone) of each meniscus will be visualized. The lateral horn is visualized in each position.

remains behind. When the patient is prone this fluid gravitates into the most dependent portion of the joint cavity, the anterior suprapatellar extension, and thus most of it is removed from the region of the menisci and allows their visualization (Fig. 2*a*).

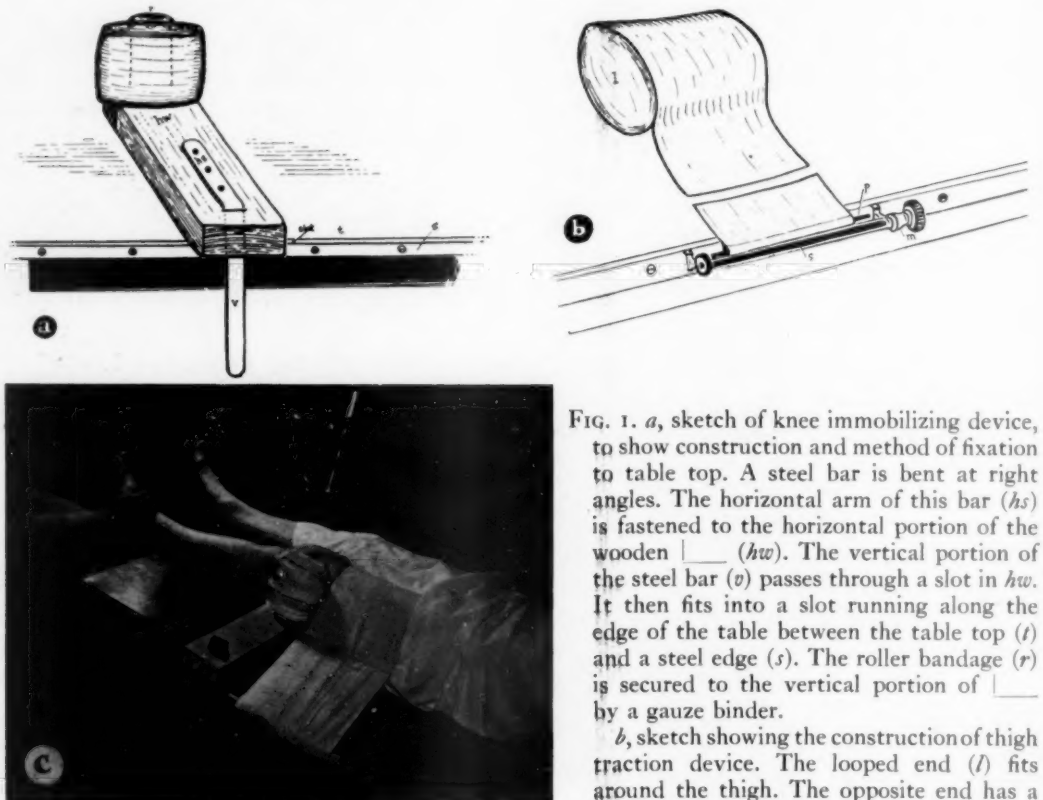


FIG. 1. *a*, sketch of knee immobilizing device, to show construction and method of fixation to table top. A steel bar is bent at right angles. The horizontal arm of this bar (*hs*) is fastened to the horizontal portion of the wooden |___ (*hw*). The vertical portion of the steel bar (*v*) passes through a slot in *hw*. It then fits into a slot running along the edge of the table between the table top (*t*) and a steel edge (*s*). The roller bandage (*r*) is secured to the vertical portion of |___ by a gauze binder.

b, sketch showing the construction of thigh traction device. The looped end (*l*) fits around the thigh. The opposite end has a small loop to receive a steel pin (*p*). This pin fits into the mechanical fixation device (*m*) of the compression band which is an accessory provided with most roentgen tables. (*s*) is the slot into which the steel pin fits.

c, photograph showing complete set-up at the time of roentgenography. The cone is not extended in the photograph for purposes of illustration. Actually it is extended so it is in contact with the knee. The knee immobilizing device is different than shown in *a*; however, the type shown in *a* is better and more rigid due to the added horizontal steel arm (*hs*). The table is in a 20° Trendenlenburg position.

(The construction of these devices will vary with different types of tables. The above are described in detail because they are suitable for many roentgen tables in military use.)

It is difficult to remove all of the fluid in a knee joint on aspiration. In this series of cases it has been found that fluid is frequently present in those knees with fractured menisci. This fluid cannot be detected clinically or by the usual roentgenograms but it interferes with adequate visualization by pneumography. Even though all the fluid possible is aspirated some apparently

However, a frothy appearance frequently results, which hinders accurate interpretation (Fig. 3*d*). Posteriorly the synovial cavity is limited in extent and is confined to the region of the joint. When the patient is supine any fluid in the joint will gravitate to this portion of the joint, which is the most dependent, and prevent visualization of the menisci. To overcome these effects of

the fluid, the following routine of positioning is employed:

(1) Following the injection of air into the joint the patient is placed in the prone horizontal position for five minutes to allow any fluid present to gravitate to the anterior compartment of the joint.

(2) While this position is maintained, the patient's leg is elevated as much as possible for about three minutes to allow the fluid to gravitate into the suprapatellar extension of the joint cavity.

(3) The table is then put in the 20 to 25 degree Trendelenburg position and the elevated leg is brought down to this level. The first set of roentgenograms are then taken. The Trendelenburg position is maintained during, in between and after the time these roentgenograms are made.

(4) Following the taking of the roentgenograms in the prone position, the patient assumes the supine posture while the table is still in the Trendelenburg position. This keeps the fluid in the anterior suprapatellar extension of the joint cavity. The set of roentgenograms with the patient supine are then taken. It may be necessary to increase the tilt to 35 degrees in this position. The roentgen tube is always kept parallel with the table top.

Using the technique outlined, we have been able to visualize the cartilages with a small amount of air, 10 to 20 cc., compared with the large amounts (100 to 140 cc.)

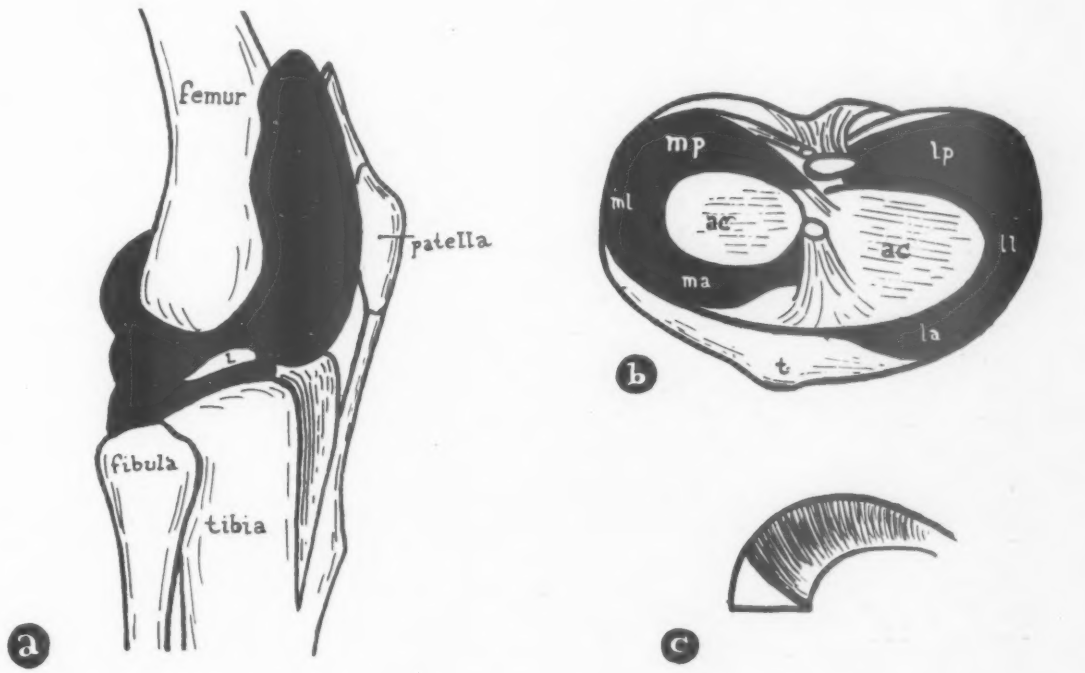


Fig. 2. *a*, drawing of knee joint region (lateral view) to show the extent and distribution of the synovial cavity of the knee joint (blackened area). It is shown distended. (*l*) represents the lateral meniscus. Note the large suprapatellar extension of the joint cavity anteriorly. Posteriorly the joint space is more limited in extent and confined to the joint region.

b, drawing to show the shape of the semilunar cartilages of the knee (blackened areas) as seen looking down on the articular surface (*ac*) of the tibia. (*m*) refers to the medial meniscus and (*l*) to the lateral meniscus. (*p*), (*a*) and (*l*) refer to the posterior, anterior and lateral horns of each meniscus. (*t*) is the tibial tubercle (anterior). The menisci are drawn as shown in standard anatomical texts.

c, a sketch illustrating a section through the lateral horn of a semilunar cartilage to show the wedge shape.

previously used. With these large amounts, most of the air is in the suprapatellar pouch. Recently it has been suggested[6] that a binder be put on the knee to obliterate this pouch and thus allow use of less air. We believe tilting is more satisfactory since it also takes care of any fluid remaining in the joint.

Most tables will tilt in one direction only. By switching the traction and immobilizing devices from one side of the table to the other, both compartments of the knee joint can be visualized in the Trendelenburg position.

In the prone position the patella, being in contact with the table, frequently is pushed over the joint spaces or prevents true posteroanterior positioning. To overcome this, the thigh is elevated about 1½ inches so that the patella is no longer in contact with the table top. The foot is always positioned so that it extends over one end of the table. This facilitates manual traction. The individual who exerts manual traction is only allowed to do this on two occasions. He is further protected by a leaded rubber apron and the use of an extension cone, the lower edge of which is in contact with the knee.

Following the examination the patient is allowed to resume his usual activities except for strenuous leg exercises, which are usually advised against for five days. The air is absorbed in about five to seven days.

INTERPRETATION OF ROENTGEN FINDINGS

1. *Roentgen Appearance of the Normal Semilunar Cartilages or Menisci.* The following brief description of the anatomy of the menisci is given to correlate their gross and roentgen appearance (Fig. 2, *b* and *c*).

The menisci are fibrocartilaginous wedges in the knee joint interposed between the femur above and the tibia below. There are two menisci, a medial and a lateral. Each meniscus is roughly part of a circle in outline.

The superior surface of each meniscus is concave, the inferior surface flat. On cross section they appear wedge shaped. The peripheral border of each cartilage is thick and attached to the capsule of the joint. The internal margin is thin and free of attachments.

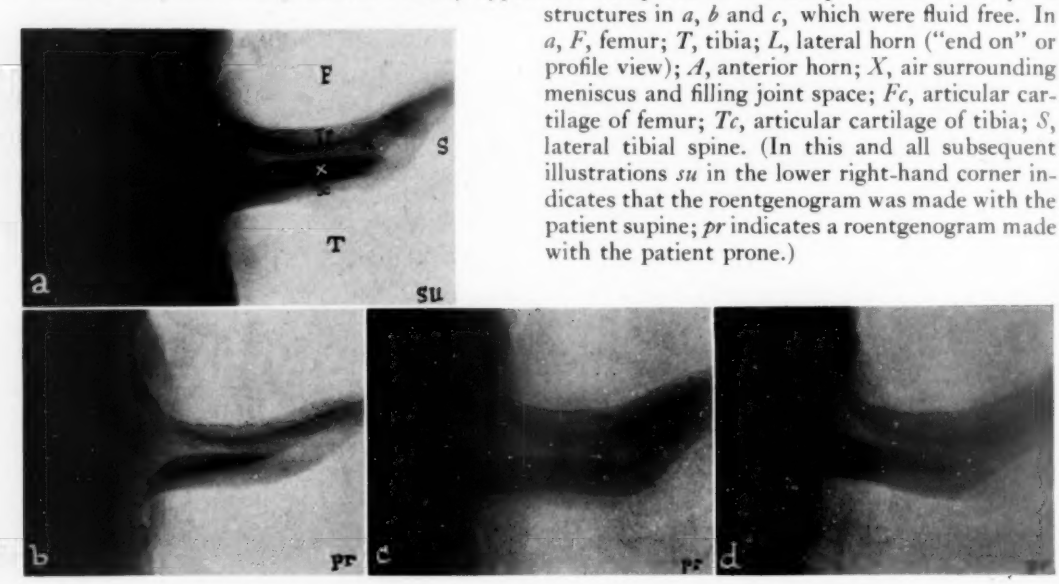


FIG. 3. The roentgen appearance of the normal lateral meniscus. In *d* there was a small amount of fluid in the joint. This produced a frothy appearance compared to the sharp outlines of the joint structures in *a*, *b* and *c*, which were fluid free. In *a*, *F*, femur; *T*, tibia; *L*, lateral horn ("end on" or profile view); *A*, anterior horn; *X*, air surrounding meniscus and filling joint space; *Fc*, articular cartilage of femur; *Tc*, articular cartilage of tibia; *S*, lateral tibial spine. (In this and all subsequent illustrations *su* in the lower right-hand corner indicates that the roentgenogram was made with the patient supine; *pr* indicates a roentgenogram made with the patient prone.)

For purposes of description, the menisci may be divided into anterior, posterior and lateral horns.

The lateral meniscus is nearly completely circular in outline. The individual horns are approximately similar in size and shape and contribute equally to the structure of the entire meniscus.

The medial semilunar cartilage is nearly semicircular in form (sickle shaped). The posterior horn and adjacent portion of the lateral horn is broader than the anterior horn and adjacent portion of the lateral horn. (These descriptions of the anatomy are from standard anatomical texts. We have not had the opportunity to examine a series of specimens.)

On the roentgenogram the lateral meniscus appears as a band of increased density, in contrast to the air above and below it, extending across the lateral compartment of the joint from the capsule laterally to the tibial spines medially (Fig. 3). For purposes of description it can be divided into two portions, a lateral one-fourth and a medial three-fourths. The lateral portion represents an "end on view" of the lateral horn and appears as a triangular or wedge shaped area of increased density with its apex pointed medially and extending for 10 to 12 mm. into the joint from its lateral capsular attachment. Its density is greater than the remaining portion of the meniscus (with one exception) because it is an "end on view."

The medial three-fourths of the meniscus is a band of fairly uniform width (4 to 6 mm.), blending with the density of the lateral horn and extending medially across the joint compartment to the region of the tibial spines. Its density is less than that of the lateral horn and is approximately equal to that of the articular cartilages. It represents either the anterior or posterior horn of the cartilage, depending on how the roentgenogram was made. Along its inferior margin is a fine threadlike line of increased density (0.5 mm. thick) which extends to blend with the density of the lateral horn. The opacity of this line approaches that of the lateral horn. It represents the widest portion of the anterior or posterior horns, that is the base. Its medial extent varies but it can be followed for about 1.5 to 2 cm. from the lateral horn. It can only be seen on roentgenograms of fine detail.

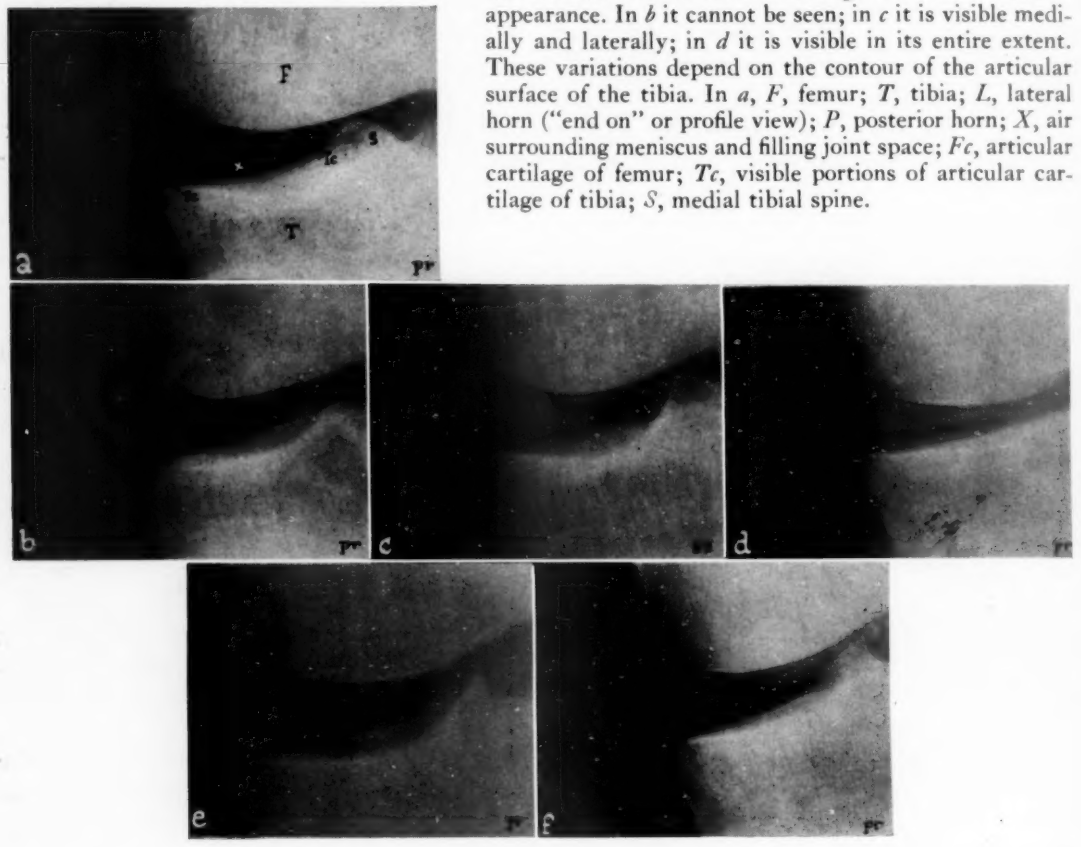
The articular cartilage of the femur and tibia is clearly visible. The width of the articular cartilage varies from 3 to 5 mm. Medially the cruciate ligament can usually be seen either in part or in its entirety. It appears as a band of uniform increased density, about 1 to 1.5 cm. wide, extending from the femur above (the intercondyloid regions) to the tibial spines below. Its density approximates that of the "end on view" of the lateral horn of the meniscus. Its borders are sharp and straight.

This appearance is fairly constant in the normal, in both supine and prone roentgenograms, there being little difference in the anterior and posterior horns and the adjacent respective portions of the lateral horn of the lateral meniscus. The lateral meniscus appears to be stretched across the joint space. This is in keeping with its known greater mobility compared to the medial meniscus.

The medial meniscus, being different than the lateral in shape, presents a different roentgen appearance (Fig. 4). The most constant and prominent feature of its roentgen appearance is a wedged-shaped area of increased density, surrounded by air, extending from the capsule laterally into the joint space medially. This represents an "end on view" of the lateral horn. Its length varies from 1 to 1.5 cm. It is quite similar in appearance and density to its counterpart in the lateral meniscus. The chief difference in the roentgen appearance of the semilunar cartilages is in the anterior and posterior horns. On the medial side these horns are not as prominent as they are on the lateral side. They may appear as gradually tapering bands of increased density extending from the apex of the density of the lateral horn toward the tibial spines with a lateral height of 3 to 4 mm. and gradually tapering to a height of about 1.5

mm. medially. Often they are seen as thin bands of increased density of fairly uniform height (about 1 mm.). It is not possible to "open" the medial compartment of the knee joint as widely as the lateral, probably due to the effect of the strong medial tibial visualization of the medial meniscus. In general, the appearance of the anterior and posterior horns of the medial meniscus is more variable than that of the lateral and the roentgen examination may have to be repeated in order to obtain satisfactory

FIG. 4. The roentgen appearance of the normal medial meniscus. *a* shows the ideal visualization of the medial meniscus. *b*, *c*, *d*, *e*, and *f* show the other types of visualization frequently encountered. Note the "crossed" appearance of the anterior and posterior horns in *e*. In *f* both the anterior and posterior horns are visualized. The articular cartilage of the tibia varies in appearance. In *b* it cannot be seen; in *c* it is visible medially and laterally; in *d* it is visible in its entire extent. These variations depend on the contour of the articular surface of the tibia. In *a*, *F*, femur; *T*, tibia; *L*, lateral horn ("end on" or profile view); *P*, posterior horn; *X*, air surrounding meniscus and filling joint space; *Fc*, articular cartilage of femur; *Tc*, visible portions of articular cartilage of tibia; *S*, medial tibial spine.



collateral ligament. Therefore, on occasions the anterior and posterior horns of the medial cartilage do not stand out clearly surrounded by air but must be traced in part through the shadow of the articular cartilage of the femur or tibia. Often both the anterior and posterior horns are visualized on the prone and supine roentgenograms and frequently a crossed appearance is obtained (Fig. 4*e*, *f* and 7*h*) In 2 instances an appearance quite similar to that of the lateral meniscus has been obtained on visualization. Factors which may contribute to this are: (1) the lessened mobility of the medial meniscus compared to the lateral, and (2) the more variable gross appearance of the medial meniscus. This has been commented on in the literature, four main types of menisci with additional combinations of these main types having been reported.[5]

The articular cartilage of the femur is clearly seen but that of the tibia is not as clearly visualized as it is on the lateral side.

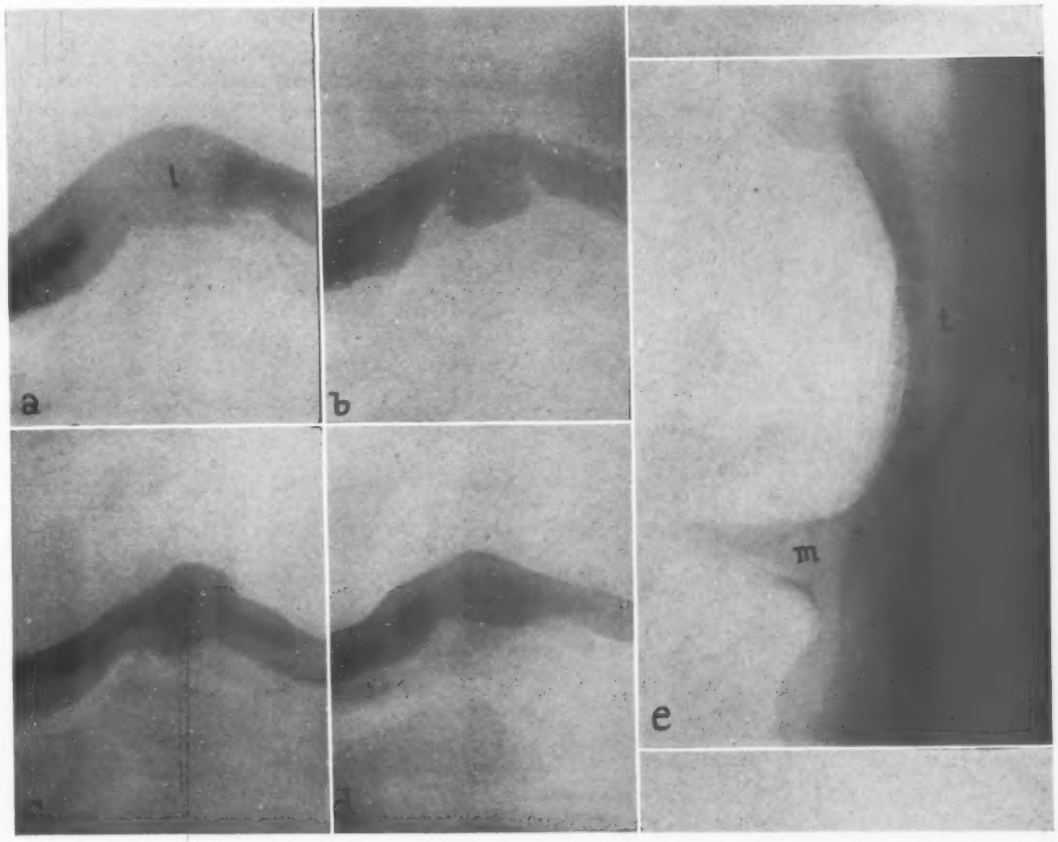


Fig. 5. *a*, *b*, *c*, and *d*, normal cruciate ligaments ((*l*) in *a*) as visualized by this technique. The outlines are sharp and the ligament is uniform in density. Most of the air is on the side of the joint being "opened up." There often is enough air in the opposite joint compartment to show the other margin of the ligament. (*t*) shows the medial tibial collateral ligament as often visualized during the filming of the medial meniscus (*m*). Note the relatively radiolucent gap (*x*) between the substance of the ligament and the capsule which is the edge of the medial meniscus.

This can be explained anatomically. The medial articular facet of the tibia is concave from side to side and from before backwards. Because of this concavity, the articular cartilage is rarely seen in its entirety, and when it is, it is only seen in 1 or 2 mm. of its height. Usually it is only visible medially near the tibial spines and laterally for a short distance. The cruciate ligament is not apt to be visualized as plainly as on the lateral side, probably because, as stated above, the medial compartment of the joint usually cannot be "opened up" as well as the lateral compartment (Fig. 5*a*, *b*, *c* and *d*).

Quite often the medial tibial collateral ligament may be seen in the soft tissues on the medial side of the knee joint on the roentgenograms made for visualization of the medial meniscus. There is usually a definite gap between its substance and the capsule of the knee joint to which the lateral meniscus is attached. This, we believe, favors the findings previously reported[2]; that is, the medial tibial collateral ligament is not firmly attached to the medial meniscus (Fig. 5*e*).

The measurements quoted in connection with the descriptions of the two menisci are approximate averages. They will vary with different target-film distances and different object-film distances, in addition to variations in individual knees.

2. *Pathological Changes in the Menisci.*

Pathological changes in the menisci may be recognized on the roentgenograms by any alteration in their appearance from the normal described above. There are no constant pathological pictures (with the exception of bucket handle tears with dislocation) because each case varies. However, if the normal appearances are understood and known, pathological changes are easily detected. In connection with the normal, it is important to point out that all the margins of the menisci are sharply defined and there are no air shadows visible within the densities produced by the parts of the menisci. The remainder of the joint space not occupied by the meniscus is clear and free of debris. The pathological changes seen may be gross or minimal and consist of fractures or tears and/or degenerative changes (thinning and fraying). Displacement of fractured segments gives rise to bizarre appearances. In some instances degenerative changes, chiefly thinning, are seen without evidence of fractures or tears. This, we be-

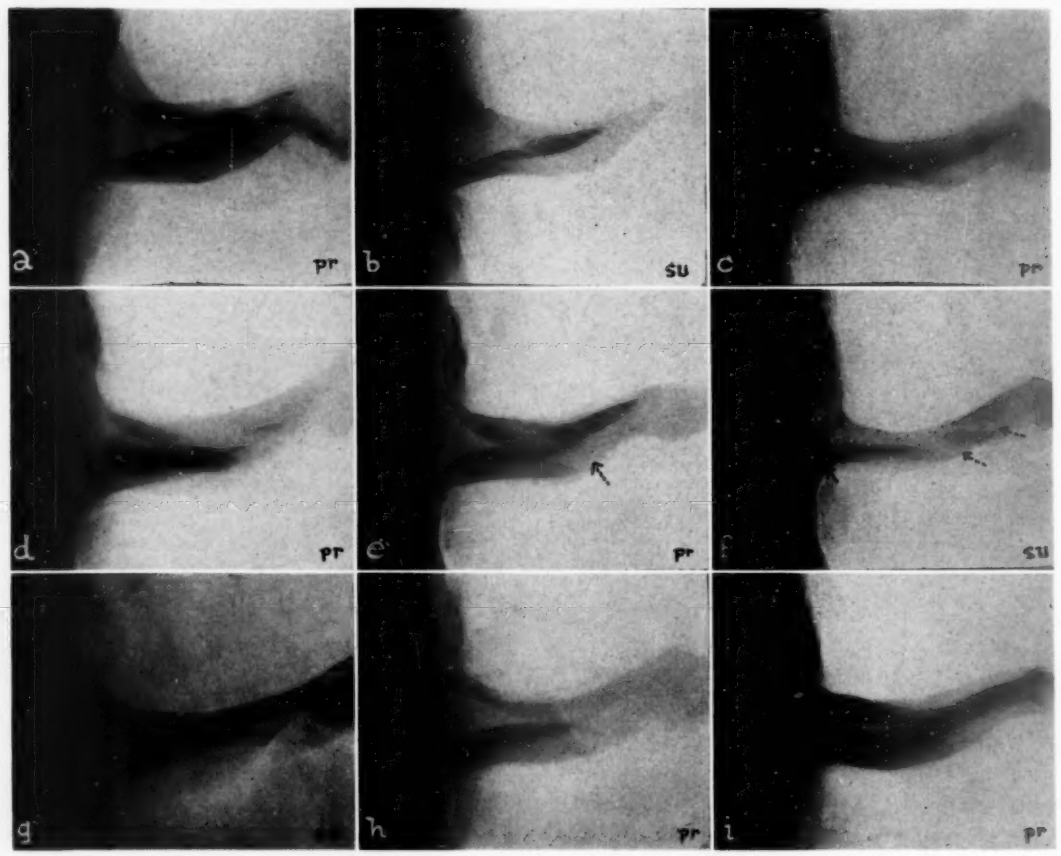


FIG. 6. Roentgen appearance of pathological lateral menisci. In *a*, *b*, and *c* the multiple tears and disintegration of the menisci are marked. In *d*, *e*, and *f* the menisci retain to some degree their gross structure. However, all show multiple tears involving both the lateral horn and the transverse horns (anterior or posterior horns depending on the position of the patient when the roentgenogram was made) of the meniscus. Note the tears in *e*, *f*, and *g* at the attachment of the lateral horn to the joint capsule (solid arrows). In *e* one end of one segment of the transverse horn can be seen at the point indicated (broken arrow). Note the split of the transverse horn in *f* (broken arrows). *h* shows a tear at the capsular attachment of the lateral horn (arrow). The remainder of the cartilage appears normal. Such a tear in the vascular zone, if detected early, might possibly heal under conservative treatment. *i* shows a cartilage in which the primary change is thinning. This is interpreted as possibly being secondary to altered knee mechanics due to a badly fractured medial meniscus, shown in Figure 7*d*.

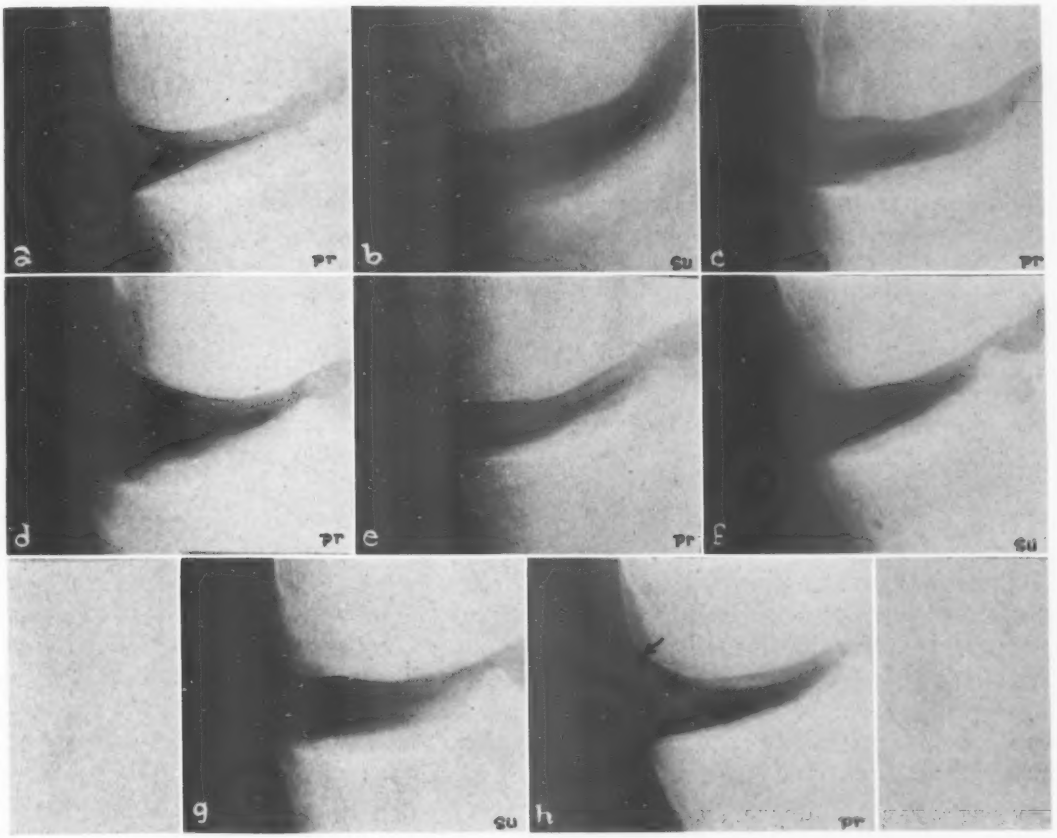


Fig. 7. Roentgen appearance of pathological medial menisci. *a* is a proved typical bucket handle fracture with dislocation of the fractured portion of the cartilage into the intercondyloid region, producing the characteristic picture described in the text. *b* is a similar case. *c*, *d*, *e*, *f*, and *g* show tears and disintegration of both the lateral and transverse horns (anterior or posterior depending on the position of the patient when the roentgenogram was made). In *h* note the crossed appearance produced by a medial meniscus which is normal except for a slight separation superiorly of the attachment of the lateral horn to the capsule (arrow). The smooth character of the defect suggests an old lesion.

lieve, is apt to occur in those instances of severe damage to one cartilage, usually fractures of long standing, in which the other cartilage, probably due to the altered mechanics of the knee joint, undergoes degenerative changes (Fig. 6 and 7).

The bucket handle tears of the menisci with dislocation of the fractured portion of the cartilage into the intercondyloid notch usually result in a fairly constant roentgen appearance; the entire joint space on one side appears full of air, the only evidence of a meniscus being a small segment of the lateral horn attached to the capsule laterally and projecting into the joint space. Most of these injuries, with the characteristic appearance described above, have been demonstrated in the medial meniscus (Fig. 7*a* and *b*).

The cruciate ligaments are often visualized. On several occasions appearances at variance with the normal have been seen. This probably represents tears of these structures. This feature will require further study.

As yet we do not know how to recognize cysts of the semilunar cartilages, abnormal laxity of the cartilages, or congenital discoid menisci, referred to in the literature.

In several cases defects of the articular cartilage over the femur have been visualized.

It is well to do pneumographic studies on several normal knees to become acquainted with the normal appearances. This will facilitate interpretation of pathologic findings. Frequently views are repeated in order to substantiate findings or obtain better roentgenograms. On at least five occasions early in the study the pneumographic examination has been repeated after several weeks, for additional information, without untoward effects.

SUMMARY AND CONCLUSIONS

By the method described above, the semilunar cartilages of the knee may be visualized. The technique is simple and can be performed in any roentgenological laboratory. It does not require hospitalization. It is harmless and has not produced any untoward effects nor aggravated any existing symptoms. The use of small amounts of air in a large joint space removes one of the chief objections to the introduction of air into a joint, that is air embolism, if such a danger exists. The technique of roentgenography insures visualization of all parts (anterior, lateral and posterior horns) of the lateral and medial semilunar cartilages. In many cases it has demonstrated the cruciate ligaments. This, however, has not been the primary objective of the examination. The articular cartilage over the tibia and femur is seen as previously explained.

Visualization of the semilunar cartilages offers the following advantages to the clinician:

(1) It will demonstrate the presence of a pathological meniscus. It is recognized that often it is difficult to diagnose a torn meniscus clinically since other lesions may give similar clinical signs and symptoms.[11,19]

(2) It will indicate which cartilage is involved. This is of importance since the differentiation may be impossible clinically. It is further important because it is often difficult to visualize the cartilage adequately in its entirety during surgery and still more difficult to visualize the cartilage on the side opposite to the side of the arthrotomy. It will, therefore, in many cases, obviate the necessity for a second incision.[11,15,23]

(3) It has demonstrated two important facts:

(a) *The lateral meniscus is fractured more often than is generally believed.* The literature quotes figures varying from 10 or more to 1 to 2 to 1 as the incidence of the frequency of medial cartilage to lateral cartilage injuries. The majority of the series reported quote the higher ratios. It is our belief that the lower ratios are more correct, the frequency of involvement of the lateral meniscus approaching and possibly equaling that of the medial meniscus. This belief cannot be supported by operative statistics since surgery was not deemed advisable in many of the cases studied. Knowledge of the frequency of involvement of the lateral meniscus may result in a decrease in the number of cases of the so-called "hypermobile meniscus." This usually refers to a grossly normal medial meniscus which has been removed after arthrotomy of the medial compartment of the knee joint on the basis that its attachments are lax, allowing the meniscus to be abnormally mobile and thus produce symptoms. However, the greater mobility of the normal lateral meniscus compared to the medial has been given as the explanation for its less frequent injury.

(b) *In many cases both cartilages are demonstrated to be pathological.* It may be that some of the unfavorable results obtained following surgery can be explained on the basis of the above two facts, namely, removal of the wrong cartilage (medial instead of lateral, judging from the statistics) or removal of one pathologic cartilage and leaving the other, which may be just as severely or more severely damaged, behind. This has been demonstrated in this series by pneumographic studies on knees which have had one cartilage (*the medial*) removed.

(4) By use of this technique, the degree of damage of a meniscus may be visualized. This, together with clinical symptoms, may be a guide as to therapy. This statement is

made with reference to marginal tears of a meniscus in the vascular zone where healing is believed possible. Such tears may be visualized in the lateral horn only. Several such cases have been found.

(5) It may show cruciate ligament tears and pathology of the articular cartilages.

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MULTIPLE MYELOMA IN A YOUTH*

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LIEUTENANT J. W. QUINLAN (MC), USNR, *and*
COMMANDER E. F. MERRILL (MC), USNR

INFANCY, childhood, and youth are the least common periods of life in which multiple myeloma is reported to occur. Geschickter and Copeland[1] reviewed a large group of reports, and found the mean age of the cases to be fifty-five years, with 80 per cent of the group between the ages of forty and seventy years. Butts[2] analyzed 40 cases of myeloma. He found the average age at the time of diagnosis to be fifty three years. There are but few reports of this disease below the age of forty years, in which the diagnosis is based upon histological studies of biopsy and autopsy tissue. Three such cases, aged thirty, twenty-seven, and twenty-two years, are noted by Geschickter and Copeland. Magnus-Levy[3] believes that the majority of cases reported to occur in children are not myeloma. However, over an eight year period he collected 7 cases of the disease in infants and children between the ages of sixteen months and twelve years. Three were plasmomas and 4 were myelobastic tumors; all were proved by autopsy or biopsy.

This paper contains the report of a case of multiple myeloma in a youth nineteen years of age.

REPORT OF CASE

A male, aged nineteen, was admitted to the hospital May 24, 1943, because of backache, which resulted from an injury in a football game a week before. After the injury he remained ambulatory, but severe pain was constant in the middle of the back, and he vomited once on the fifth day. A roentgenogram taken the day before admission revealed a fracture of the seventh dorsal vertebra.

The only item of positive interest in the past history was the occasional occurrence of night sweats, which the patient attributed to an excess of blankets. He had had mumps, with involvement of the left testis. There had been no loss of weight, and the general health of the patient was good. This last was verified in a letter from the parents.

The admission temperature was 100° F., the pulse rate 88, the respiratory rate 20, and the blood pressure 120/70. Tenderness in the area over the seventh dorsal vertebra and some paravertebral tenderness were the only positive physical findings. The neurological examination was negative. The regional lymph nodes were not enlarged. No masses were palpable in the renal areas, and the breasts were normal. The left testis was atrophic, but the right testis was of average size. The rectal examination was negative.

Roentgen Findings. May 26: "There are multiple areas of decreased density, irregular in shape, in all the ribs, in both scapulae, both clavicles, and in some of the vertebrae of the dorsal spine. There is also a fracture of the anterior portion of the fourth rib on the right side, and a compression fracture of the seventh dorsal vertebra. There are questionable areas of rarefaction in both innominate bones which might be bony disease or overlying colonic gas. Opinion: Multiple myeloma." May 28: "The mottling of the pelvic bones is again seen, as well as mottling in the upper ends of both femurs and in the sacrum. The same mottling is noted in the skull. The findings are most consistent with multiple myeloma." July 6: "Films of ribs, lateral skull, dorsal spine and pelvis show no changes since the last examination."

On June 10 a sternal puncture was done. Smears showed bits of marrow, in which no tumor and no predominance of plasma cells were evident.

Laboratory Findings. Urinalysis was negative, except for coarsely granular and hyalin casts in one specimen. On five occasions, tests for Bence-Jones protein were negative. Five erythrocyte counts expressed in millions per cubic millimeter were: 3.55, 2.89, 3.07, 3.13, and 2.49. Hemoglobin determinations by the Hayden-Hausser method were: 8, 8.5, and 7.5 gm. per 100 cc. Leukocyte counts were 5,000, 2,650, 1,550, and 4,700 per cu. mm. Three differential

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leukocyte counts averaged: juvenile cells 1 per cent, band cells 2 per cent, segmented cells 54 per cent, lymphocytes 40 per cent, and monocytes 3 per cent. No abnormal types of cells were seen. In the smears there were hypochromia and slight anisocytosis of the red blood corpuscles. A blood platelet count was 125,000 per cu. mm. The blood Kahn test was negative. The erythrocyte sedimentation rate, Cutler method, was 33 mm. in one hour. Blood chemistry determinations: total protein 9.7 per cent, albumin 4.09 per cent, globulin 5.61 per cent, non-protein nitrogen 42 mg. per 100 cc., calcium 8 mg. per 100 cc., phosphatase 22 Bodansky units, sugar 136 mg. per 100 cc. A phenolsulfonphthalein renal function test showed the following excretion rate: fifteen minutes, 15 per cent; one hour, 35 per cent; two hours, 25 per cent. Total excretion of dye, 75 per cent. Mosenthal's renal function test gave the following results: 990 cc. of urine excreted during the day, 600 cc. excreted during the night, total excretion, 1,590 cc. for twenty-four hours. The specific gravity ranged from 1.007 to 1.013.

On June 13 a biopsy was taken from the eighth right rib in the anterior axillary line. Most of the cancellous bone was replaced by soft, bloody, reddish-gray tissue leaving a thin shell of cortex surrounding it. Sections of this soft tissue were examined by the pathologist at this hospital, and unstained sections from the same blocks were submitted to three other pathologists for their opinion. The four reports are given in the sequence received.

Fig. 1. Typical lesions in ribs, scapulae, and clavicles. Note that the ribs are closer together at the level of the compressed seventh thoracic body.

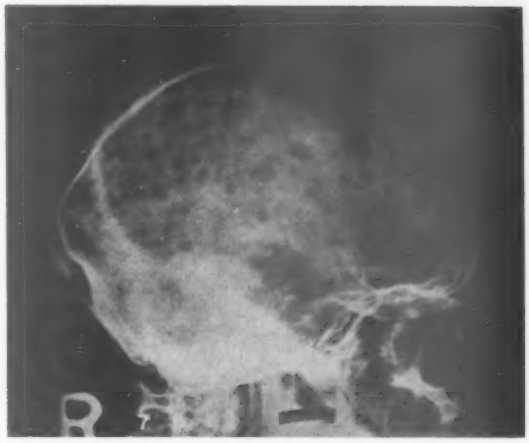

Fig. 2. Note the multiple destructive bone lesions involving primarily the diploic portions of the bone.

1. Report of Lt. Comdr. Harold Wood, Pathologist, U. S. Naval Hospital, Newport, R. I.

"Sections revealed a hyperplastic cellular bone narrow, showing overgrowth with unidentified mononuclear cells, but with some plasma cell types. There were numerous cells representing normal marrow cell types. Mitoses were not common. Bone resorption (in the spicules) was prominent. Opinion: Suggestive of myeloma, but am unable to make a definite diagnosis on these sections."

2. Abstract of letter from Lt. Comdr. Shields Warren (MC), USNR, New England Deaconess Hospital, Boston, Massachusetts, Consultant in Pathology for the First Naval District: "The clinical history is certainly a good one for multiple myeloma, and the serum protein is elevated particularly in view of the anemia present. The sections show some typical plasma cells, especially in the section with a moderate amount of bone present. In other sections, the cells are less typical, but some of the plasma cell type are there. I would, therefore, classify this case as one of multiple myeloma of plasma cell type, not completely characteristic."

3. Abstract of letter from Dr. H. E. MacMahon, Professor of Pathology and Bacteriology, Tufts College Medical School, Boston,

FIG. 3. Multiple typical lesions of plasma cell myeloma in the pelvic bones with no evidence of cortical destruction.

Mass.: "I spent a good deal of time yesterday going over the three slides that you sent us. In only one of the three sections was there any recognizable tumor tissue. The growth is composed of a very primitive cell. There is little cytoplasm and the nucleus is rather polymorphous. There is no pattern as far as the growth is concerned, so that one is merely left with cells from which one might reach a diagnosis. Ninety-nine per cent or more of the cells are so primitive and undifferentiated that they cannot be compared with any adult cell found normally in bone marrow nor, for that matter, in the developing marrow of the embryo. Among these cells, there is a very occasional well formed plasma cell. The appearance of plasma cells in bone marrow is not an uncommon finding, so that finding one or two of these might have no more significance than were one to pick up a mature red cell or a polymorphonuclear leukocyte or even a megakaryocyte under similar circumstances. I believe, however, that I was able to trace transitions between the dominating cell and a plasma cell. If this observation is correct, then the presence of a plasma cell assumes considerable significance. It is a little bit like spending an afternoon or an evening looking through one of those undifferentiated retroperitoneal tumors and coming out in the end by finding a single cell with cross striations which you can recognize as a striated muscle fibre. When we do this we are very apt to label our tumor a rhabdomyosarcoma. In the same way my diagnosis of your slide might be a plasma cell myeloma and yet, actually, it is a tumor that might more accurately be called an undifferentiated myeloma."

4. Report of Lt. Comdr. C. F. Geschickter (MC), USNR, Pathologist, U. S. Naval Hospital, Bethesda, Maryland:

"The sections show eroded spicules of bone widely separated by hyperplastic marrow. In places the normal bone marrow is crowded out by a proliferation of cells slightly larger than lymphocytes. They have either circular or lobed nucleus with a fine distribution of chromatin. There are occasional mitotic figures. The majority of these cells are not the characteristic plasma cells found in the usual type of multiple myeloma. The cells seem to be more immature in form and of the myelocytic series and have a tendency for their nuclei to split into lobes. Pathologic diagnosis: Multiple myeloma, primitive myelocytic series."

During the remainder of the stay in the hospital, the patient was reasonably well. There were occasional elevations of temperature, up to 101.3° F. The blood pressure was 125/70. The pulse rate varied from 79 to 98, and the respiratory rate varied from 16 to 30. Back pain of moderate intensity persisted. Three small transfusions of citrated blood were given. At one time a systolic murmur was heard over the mitral area, but there was no tachycardia. Except for one period of faintness, and two days of nausea and vomiting, the course was uneventful. The biopsy wound healed uneventfully. On July 5 the patient was transferred to

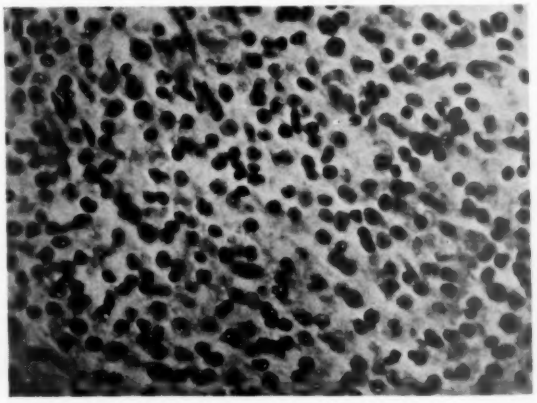

FIG. 4. Biopsy specimen which illustrates the undifferentiated character of the tumor cells; the remote resemblance to plasma cells of the chromatin distribution in some of the cell nuclei; and the lobulated appearance of some of the nuclei.

the U. S. Naval Hospital, Brooklyn, New York, for palliative roentgen therapy.

Progress note from Brooklyn Naval Hospital, September 22, 1943: "Further roentgen studies supported by a review of the biopsy have established the diagnosis as being multiple myeloma. Treatment has consisted of small doses of roentgen therapy to the chest and pelvis. Generally this patient has improved and has no complaints except for weakness. Follow-up roentgen studies, however, show extensive and uncontrolled disease involving almost the entire skeletal system."

SUMMARY

A case of multiple myeloma in a youth, aged nineteen, has been presented. The disease was discovered following a pathological fracture of a vertebra. Roentgenographically the appearance and distribution were typical. A biopsy from a rib was examined by four pathologists. The consensus was that the tumor is a primitive atypical myeloma, but there was some uncertainty and difference in opinion as to the cytogenesis of the tumor; that is, whether it developed from the plasma cell or the granulocytic series of marrow cells.

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CHOLEDOCHODUODENAL FISTULA

CASE REPORT

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SPONTANEOUS internal fistula of the biliary tract, although by no means considered rare, does not occur sufficiently often so that it may be diagnosed readily. In fact, clinically, the condition is so obscure that almost complete reliance must be placed upon roentgenographic study for a diagnosis to be made. During the past fifteen years more cases have been reported than ever before because of the awareness of roentgenologists of its existence and the improved technique of roentgenography.[1,2,3,4,5,8,9,10,11,13] These lesions may be practically unsuspected clinically simply because of the existence of a wide stoma at the point of the fistula and thus they are only demonstrable at the time of roentgen studies.

The causes of retrograde filling of the biliary tract during the course of studying the alimentary tract by the use of barium may be listed as follows:[4,8,12] (1) the penetration of gallstones from the gallbladder or, very much less frequently, the common duct, into the duodenum; (2) the extension of an inflammatory process by contiguity from the gallbladder, or the common duct, to the duodenum, or vice versa; (3) the establishment of contiguous inflammation and fistula formation arising from a primary lesion in the colon; (4) operative interference resulting in either a cholecystoduodenostomy or cholecystogastrostomy; (5) the questionable physiological reflux from the duodenum through a patent sphincter of Oddi into the biliary tract.

The above causes have been listed in the order of their supposed frequency of occurence.

As to the possibility of physiological reflux via the ampulla of Vater, experimental work by Beal and Jagoda[1] showed that it was relatively impossible to fill the biliary tract in a cadaver even by the use of enormous amounts of pressure exerted from within the duodenum.[7] The demonstration of a fistulous communication between the biliary tract and the colon is best made by means of a barium enema.[4] The presence of air alone in the biliary tract is by itself diagnostic evidence of the existence of a fistula between the biliary and alimentary tracts.

Borman and Rigler[2] have aptly summarized the roentgenologic criteria for the diagnosis of internal biliary fistula as follows:

1) Direct Signs.
   a) Gas or barium or both in the gallbladder or biliary tree.
   b) Mucous membrane changes at the stoma of the fistula.
2) Indirect Signs.
   a) Non-functioning gallbladder (cholecystogram).

In differentiating gas in the biliary tract resulting from a fistula and gas resulting from emphysema in bacterial infection within the gallbladder, the latter is more apt to be bubble-like in its appearance and usually does not extend beyond the confines of the gallbladder shadow and cystic duct. As a further aid in establishing the diagnosis of internal biliary fistula, cholecysttography is of value since it usually reveals either a non-functioning or poorly functioning gallbladder. The finding of a normal gallbladder shadow, in a case where the barium meal study has suggested the possibility of internal biliary fistula, should cause one to reconsider the latter diagnosis.[6,14]

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The case we are reporting is one in which we believe the course of the disease was such that the original pathologic condition occurred in the duodenum and spread by contiguity to the common duct with a resultant fistula formation.

CASE REPORT

A white male selectee, aged thirty-two, reported for induction in December, 1943. He gave the following history:

He was perfectly well until six years ago when he noticed the onset of epigastric pain at night

Fig. 1. Demonstration of the irregular, deformed duodenal cap with the Y-shaped fistulous tract issuing therefrom outlining the common, cystic and common hepatic bile ducts with some barium in the neck of the gallbladder.

which was so severe that it aroused him from sleep. He obtained relief by taking sodium bicarbonate. This symptom persisted for the next five years during which there were periods of approximately two to three weeks when it would be manifest and then again periods of three to four weeks' duration when there would be complete freedom from all symptoms. About one year ago he noticed that the pain began to occur regularly about two hours after each meal during the day, besides its occurrence during the night. He still continued to obtain

Fig. 2. The right oblique view showing the same as Figure 1.

relief from the use of alkalies. His chief complaint at the time of examination was localized epigastric pain which came on about two to three hours after meals and which was relieved by food, but especially by the use of magnesium

Fig. 3. A roentgenogram six hours after the ingestion of the barium showing air in the biliary tract and flecks of barium in the gallbladder.

FIG. 4. Very poorly visualized gallbladder shadow following the oral administration of three doses of tetraiodophthalein with a very tiny amount of residual barium in the fundus of the gallbladder. (Cholecystography was performed shortly after the barium series because of the limited time allowed for study of this case.)

hydroxide and somewhat by milk. By this time the pain was present both day and night, with the night symptoms more marked. He had frequent vomiting spells which gave him relief. At no time did he experience any single episode of acute, sudden, sharp abdominal pain. There had never been any diarrhea. Neither had there been any hematemesis or melena. During the entire course of his illness he never visited a physician. His family history was irrelevant. He was employed as a porter in a factory. He took alcohol in minimal quantities; he rarely smoked. He had no previous illness or injuries. He denied venereal disease.

Physical examination revealed a small-framed, thin male who appeared in some slight distress. His facies was markedly triangular with deep nasolabial grooves conforming to the type of facies described by Draper as the "ulcer facies." Examination of all systems was entirely negative except for the presence of a single small area of exquisite tenderness in the epigastrium at a point slightly above midway between the xiphoid and the umbilicus.

Roentgenographic Examination. During the course of the ingestion of the barium meal the duodenal cap appeared deformed and somewhat irritable. At that time no evidence of communication between the cap and the biliary tract was observed. However, the roentgenograms revealed the barium-filled outline of the cystic, common hepatic, and common bile ducts with barium in the gallbladder itself and also air in the biliary tract in some of the roentgenograms. Oral cholecystography was performed and it was found that the gallbladder concentrated poorly. During cholecystography, however, it was not possible to show the communication by contrast medium between the biliary tract and the duodenum, but again air was seen in the biliary tract. The roentgenograms were interpreted as representing an old duodenal ulcer which had formed a fistulous communication with the common bile duct.[5]

Since the study was carried out for diagnostic purposes only the selectee was rejected for service in the Armed Forces and advised to see a physician.

SUMMARY

(1) A case of choledochoduodenal fistula is presented.

(2) A brief review of some of the pertinent literature is noted.

(3) Some of the roentgen diagnostic criteria of this condition are stressed.

The authors are indebted to Sgt. P. Murphy and T/5 G. Dickey of the WAC Medical Detachment for their assistance in studying this case and to Cpl. H. Owen of the Signal Corps for the reproductions of the roentgenograms.

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PHOTOELECTRIC TIMING IN GENERAL ROENTGENOGRAPHY*†

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INTRODUCTION

IN A PREVIOUS publication on the automatic control of roentgenographic exposure, one of us described a photoelectric timing mechanism[1] that has been in use for more than two years on our gastric filming fluoroscope. A similar timer suitable for photofluorography[2] has been developed in our laboratory and for many months a number of these units have been in operation on photofluorographs belonging to the United States Navy, the United States Army and the United States Public Health Service. One of these, at the time of this writing, has made over 100,000 exposures.

For the past two years our laboratory has been under contract with the Office of Scientific Research and Development, and at the request of that agency we have applied for several patents covering various phases of our work. The University and the authors retain no financial interest whatever in these patents, and have assigned all of them to the government. The scarcity of electronic materials makes it impossible for commercial manufacturers to supply phototimers for civilian use at this time, but the government has licensed several companies and as soon as war restrictions can be relaxed commercial phototimers will be produced.

The present paper deals with the application of automatic timing to general roentgenography, which includes the roentgenographing of such parts as the spine, the pelvis, the urinary tract, the gallbladder, the chest, the shoulder, the skull, the knee, the ankle, etc., with and without intensifying screens and with and without the Potter-Bucky grid. Automatic phototimers consist of two parts—a detector unit and a condenser-thyratron-relay system which for convenience we call the "control chassis." In the exposure meter[3] the detector is a lightproof metal box provided with a cover that is transparent to roentgen rays and containing a 931 phototube and an overlying fluorescent screen. The detector we have used for photofluorography[2] focuses on the active surface of the phototube a 4 by 10 inch segment of the fluoroscopic image of the upper lung fields. In our gastric-filming fluoroscope the phototube lies $1\frac{1}{2}$ inches in front of the $4\frac{1}{4}$ by 7 inch fluoroscopic screen and scans the entire screen.[1]

When roentgen rays fall on the fluorescent screen, it emits visible light which causes the phototube to conduct a small electrical current. The magnitude of this photocurrent is proportional to the light emitted by the screen, and therefore to the intensity of the roentgen rays that induced the visible radiation. The photocurrent enters the control chassis where it is collected by a condenser and when the charge on this condenser reaches a critical value the thyratron system ionizes and activates a normally closed relay which in turn interrupts the roentgen-ray exposure.

The time required for the charging of the condenser determines the length of the exposure and varies with the voltage applied to the phototube, the size of the condenser and the intensity of the radiation reaching the detector. The first two factors are fixed at the time the instrument is calibrated,

* The work described in this paper was done under a contract recommended by the Committee on Medical Research between the Office of Scientific Research and Development and the University of Chicago.
† Presented at the Joint Meeting of the American Roentgen Ray Society and the Radiological Society of North America, Chicago, Ill., Sept. 24–29, 1944.
‡ Surgeon (R) United States Public Health Service.

leaving only the third factor variable depending on the output of the roentgen tube and the thickness and density of the part being examined. All else being equal, the thicker the part, the lower will be the intensity of the light emitted by the fluorescent screen, and therefore the longer the time for charging the condenser and the longer the roentgen-ray exposure.

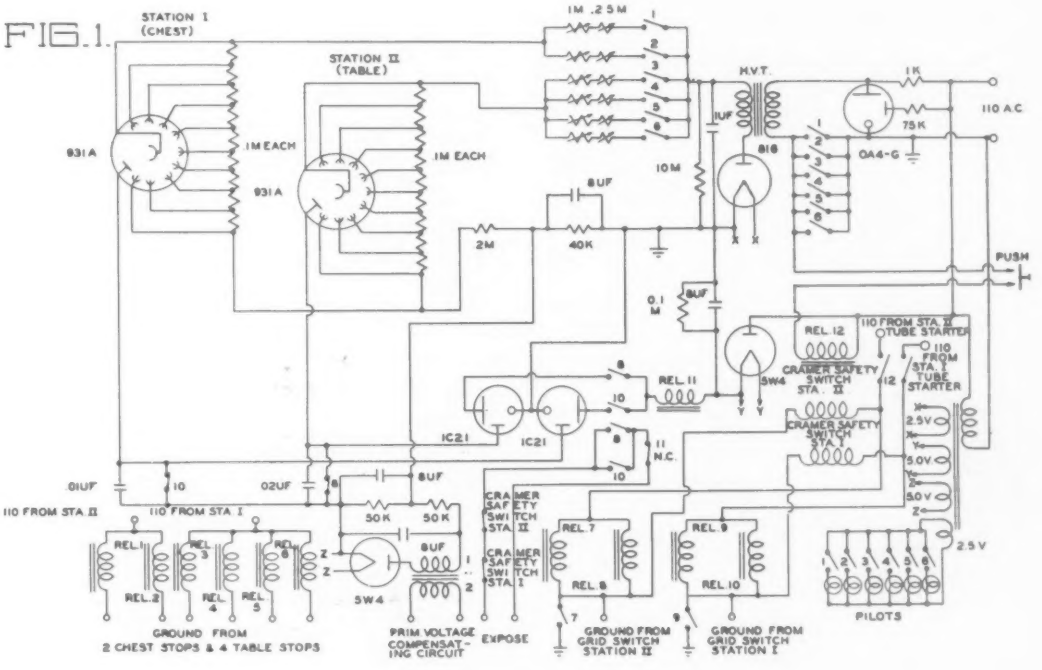


FIG. 1. Two-station, multiple-stop phototimer.

RADIATION DETECTOR FOR GENERAL ROENTGENOGRAPHY

Experience with the 2 by 2 inch detector of the exposure meter[3] has shown us that for some phases of general roentgenography such a surface is too small, for others too large. The small surface serves well for the skull, knee, shoulder, and gallbladder but is too small for the trunk and pelvis and too large for the hand and wrist. For trunk and pelvic roentgenography a larger detector gives better results by minimizing the effects of local areas of decreased density, such as pockets of gas in the bowel; but such large detectors fail in the case of the gallbladder, knee, etc., because they are influenced by radiation passing around as well as through the region of interest. For the same reason the hand and wrist require very small detectors.

In a preliminary model, we provided multiplicity of detector sizes by employing a 7 by 7 inch detector mounted beneath the film tray of a Potter-Bucky grid and interposing between film and detector lead sheets having various sized openings or "stops." That detector, a roof-shaped, light-tight metal box with the phototube at the apex and the fluorescent screen (Patterson photoroentgen) at the base, had an over-all thickness of about 5 inches, which precluded its use on grids mounted in conventional tilt tables. By moving the phototube to the side of the detector box with its active surface directed obliquely toward the screen and toward a mirrored image of the screen, the thickness of the detector has been reduced to $1\frac{3}{4}$ inches, of which $\frac{3}{4}$ inch can be countersunk into the base of the grid (Fig. 13 and 14). This means that the

thickness of the Potter-Bucky grid complete with radiation detector is $3\frac{3}{4}$ inches, which is 1 inch thicker than the conventional grid.

Some commercial tilt tables will take a $3\frac{3}{4}$ inch grid, and it is hoped that the manufacturers of the others may be able to find means of altering them so that they too will take grids equipped with radiation detectors.

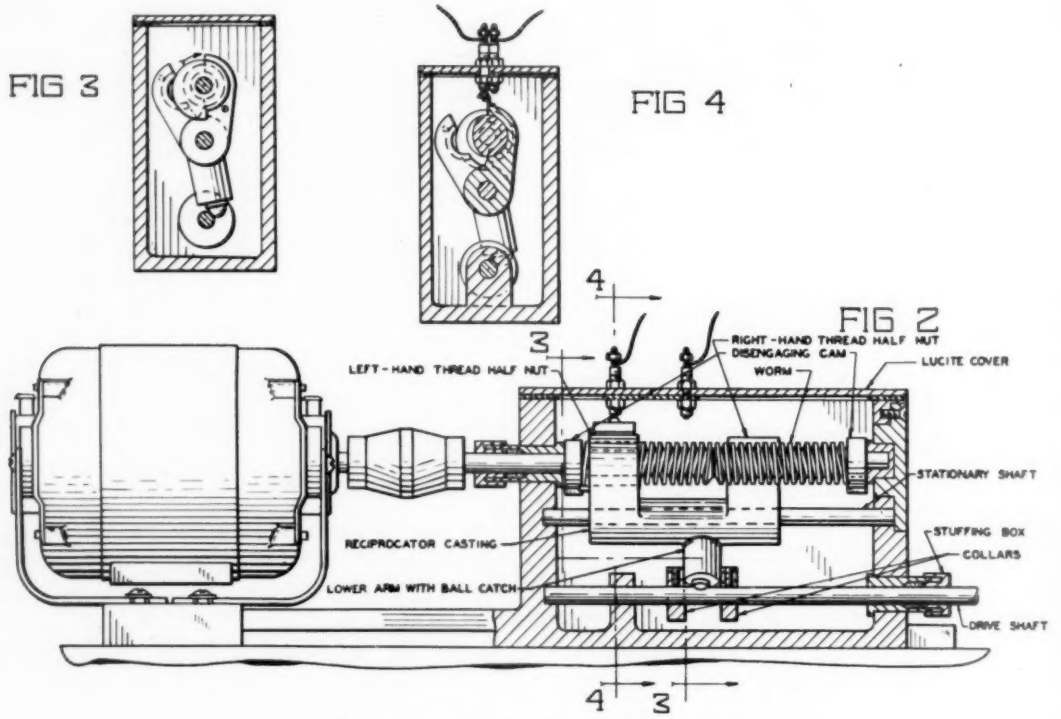


FIG. 2, 3 and 4. Detail of reciprocator.

DISC WITH MULTIPLE STOPS

In the experimental model we placed the various lead stops in the bottom of the film tray but in the current model the stops are attached to a steel disc mounted below the tray and above the detector (Fig. 5, 6, 8, 10, 11 and 12). A short axle fixed to the disc passes downward through a brass bushing and is retained by a brass bar known as the "grounding bar." A spring lock engaging four notches on the periphery of the disc registers each of the stops precisely above the detector, and lettering and a symbol on the exposed edge of the disc indicate which stop is in position. Four squares of lead cemented to the upper surface of the disc cover the detector completely except for the holes or "stops" that are cut through the lead and steel.

Stop No. 1: This has a 2 inch circular aperture located at the center of the detector. It is used with 8 by 10 inch and 10 by 12 inch cassettes where there is no central spring to obstruct passage of the rays and is employed for examination of the skull, gallbladder, shoulder, knee, etc.

Stop No. 2: Sixteen apertures, each $\frac{1}{2}$ inch in diameter, are located four in each corner of the detector, leaving vertical and transverse bands of intact lead between the four groups of holes. This arrangement distributes sampling over a wide area and cancels the effect of the central spring if 14 by 17 inch cassettes are used but may, however, be used with smaller size films as well. This stop is used for roentgenographing the chest, abdomen, and pelvis.

Stop No. 3: Four apertures, each $\frac{7}{8}$ inch in diameter, are placed two above, two below the center of the detector with a $\frac{3}{4}$ inch band of lead separating the pairs. This stop is employed primarily for lateral roentgenography of the spine and may be used with cassettes of any size.

Stop No. 4: This stop has a single $\frac{1}{2}$ inch aperture placed at the center of the detector and is used for roentgenographing the hand, wrist, fingers, and toes.

GROUNDING COMMUTATOR

A circular bakelite plate equipped with four brass contact buttons placed at 12 o'clock, 3 o'clock, 6 o'clock, and 9 o'clock is clamped to the base of the grid by the nut of the bushing in which the axle turns. Brass pins that fix the buttons in the bakelite are soldered to wires that lead to the chassis and a thin sheet of fiber insulates this part of the assembly from the frame of the grid. The bushing and axle, however, are in electrical contact with the frame of the grid, which in turn is connected to ground, and a ball catch at the outer end of the grounding bar distributes ground to contact buttons No. 1, 2, 3 or 4, depending on the particular stop that is registered over the detector. If stop No. 3 is in front of the detector, commutator button No. 3 delivers ground to the chassis but buttons No. 1, 2 and 4 are dead. If none of the stops is centered directly over the detector—that is, if the disc is not properly set with its spring lock engaging one of the four notches at the periphery—all the contact buttons are dead and the machine will not operate.

DETECTOR FOR ROENTGENOGRAPHY OF THE CHEST

This detector, oblong in shape and equipped with a $3\frac{1}{2}$ by 10 inch Patterson photoroentgen screen, is placed transversely behind the film carriage, its lower edge at the center of the film. The disc-axle-commutator assembly is similar to that used with Station II except that here only two stops are used.

Stop No. 1: This stop has two $3\frac{1}{4}$ inch apertures, one at either end of the detector screen. It is used for the frontal view of the chest.

Stop No. 2: This is a single 2 inch aperture in the center of the detector and is used for lateral roentgenography of the chest.

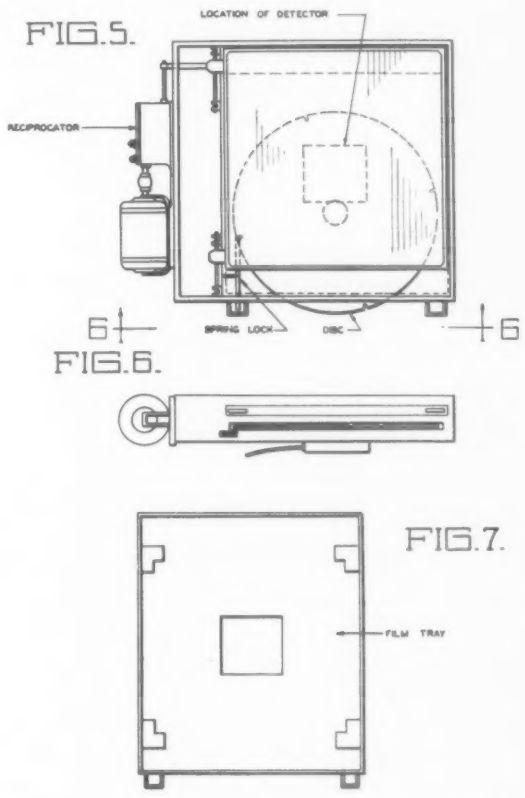


Fig. 5. Grid, reciprocator, stop, detector assembly viewed from above.
Fig. 6. Same, viewed from the side.
Fig. 7. Film tray.

SPECIAL CASSETTES

It is essential that all film holders used with phototimers have radiolucent backs. In the case of cardboard holders this requires merely the removal of the sheet lead from between the film envelope and the cardboard, but in cassettes one must not only remove the lead but also make sure that the back is of radiolucent material, such as aluminum or plastic. As far as we

have been able to determine, the lead that is always placed in the backs of film holders serves no useful purpose.

We prefer cassettes in which the 14 by 17 inch size has three transverse spring straps, the 10 by 12 inch and 8 by 10 inch size only two; but any cassettes will serve provided they are all the product of one manufacturer, and therefore all of approximately the same degree of radiolucency.

FIG 8

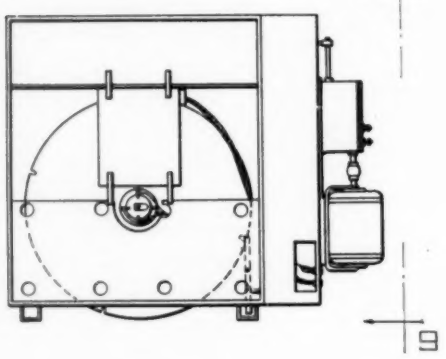


FIG 9

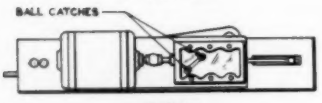


FIG 10

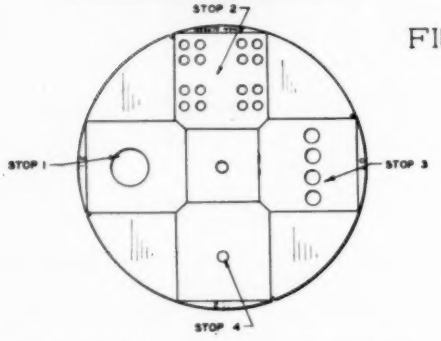


Fig. 8. Grid assembly viewed from below to show detector and grounding commutator.
Fig. 9. Plan of reciprocator to show location switch on lucite cover.
Fig. 10. Detail of disc with four "stops."

FILM TRAY

A $5\frac{1}{2}$ by $5\frac{1}{2}$ inch window is cut out of the center of the film tray to allow radiation that has come through the patient and the film to enter the detector. This requires discarding the cassette clamp provided by the manufacturer and employing plywood adaptors when 10 by 12, 8 by 10 and 7 by 17 inch films are used.

MOTOR-DRIVEN RECIPROCATOR FOR THE POTTER-BUCKY GRID

Much of the advantage of phototiming would be lost if conventional Potter-Bucky grids were employed because it would be necessary to make an empirical estimate of the exposure time and then set the grid for a travel time something greater than that. With the reciprocator the grid starts as soon as the station switch is closed and the rate of travel remains constant regardless of the length of exposure.

With the years, roentgenologists have come to accept the dictum that the Potter-Bucky grid must be in motion before the exposure starts and must continue in motion until after the exposure has ended, but actually it is permissible for the grid to stop and reverse direction while the exposure is in progress, provided the stoppage is brief. We have determined experimentally that a reversal accomplished in approximately 1/100 second is sufficiently fast to prevent grid lines provided the exposure time exceeds $\frac{1}{2}$ second; and, with the able assistance of our precision machinists, Mr. Angrabright and Mr. Doles, we have been able to develop a reciprocator having this characteristic.* The current model of the reciprocator is shown in Figures 2, 3 and 4.

A rubber-mounted 1/40 horsepower, alternating current motor drives a worm at a constant speed of 1,725 r.p.m., rotation being clockwise as one looks at the outer end of the worm. The inner half of the worm (that is, the end toward the motor) has a left-hand thread, the outer half a

* Early models of the reciprocator were demonstrated at the meeting of the American Roentgen Ray Society in September, 1942, and the Radiological Society of North America in December, 1942.

right-hand thread. Sliding on a stationary rod located below the worm is a reciprocating member that has two upper arms, each bearing a half-nut that faces the worm, and a single lower arm equipped with a ball catch. Below the stationary rod lies a drive shaft which slides in a bearing, carries a pair of collars to engage the lower arm of the reciprocating member, and at the outer end passes through a stuffing box to drive the grid. When the motor runs, the grid moves back and forth making a complete cycle in 1.5 seconds and reversing direction in approximately 1/115 second. When a 50-line grid is used, grid lines do not become noticeable until the exposure time is reduced below 0.2 second.

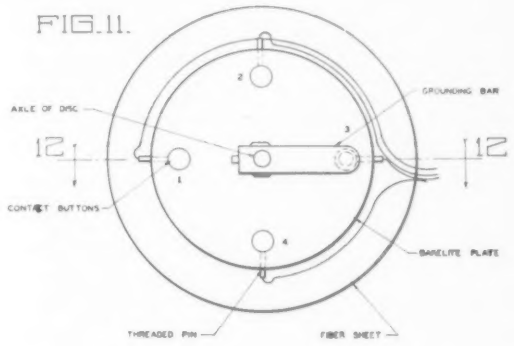
OPERATION OF RECIPROCATOR

When the right-hand thread half-nut is engaged with the outer half of the worm, the grid is driven outward—that is, away from the motor—until a cam attached to the outer end of the worm strikes a disengaging pin in the nut, forcing it out of engagement. This brings the left-hand thread half-nut into engagement with the central portion of the inner half of the worm. As the right-hand thread half-nut is forced away from the outer end of the worm, the ball catch in the lower arm of the reciprocating member rides over the drive shaft and snaps down on the other side, completing the thrust that was begun by the disengaging cam and retaining engagement between the left-hand thread half-nut and the worm. The grid now travels inward until the left-hand thread half-nut is disengaged by a second cam at the inner end of the worm, upon which the grid reverses again—the cycle being repeated as long as the motor continues to run.

When they are properly adjusted, the cams disengage one half-nut and engage the other 90° after they strike the disengaging pins, and since the worms and cams revolve at 1,725 r.p.m., this means that reversal is accomplished in approximately 1/115 second.

GRID SWITCH

The worm, half-nuts, cams, etc., run in oil to reduce wear and noise, and the lucite cover of the oil housing carries a switch which delivers a pulse of ground just after each reversal of the grid. This switch consists of two ball catches attached to the lucite cover and connected together by a metal strap (Fig. 9). As the grid reverses and starts to move inward, a metal trigger



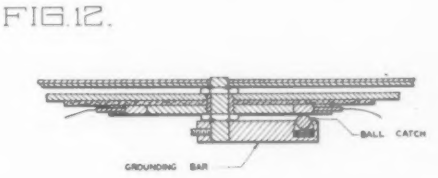


Fig. 11. Detail of grounding commutator viewed from below.

Fig. 12. Section through disc, axle, bushing, and grounding commutator.

attached to the left-hand thread half-nut momentarily strikes the outer ball catch but passes the inner catch without touching it. On the outward trip the trigger strikes the inner ball catch but passes the outer one. By means of the grid switch and a self-holding relay (Fig. 1), exposures shorter than 0.6 second may be made without grid reversal, whereas longer exposures continue through one or several reversals of the grid. The relay is connected so that one side of its coil receives ground from the grid switch and the other side receives 110 volt A.C.

when the exposure switch is closed. After the exposure switch has been closed there is a momentary delay until the grid begins to travel in a new direction and a pulse of ground comes from the grid switch. A pair of normally open relay contacts provides a self-holding circuit so that once the relay has closed it remains closed as long as the exposure switch is held down, and a second pair of normally open contacts initiates the roentgen-ray exposure.

FIG. 13.

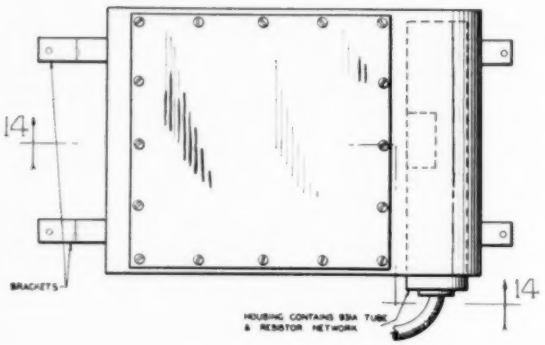


FIG. 14.

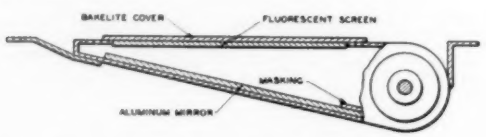


FIG. 13. Detector viewed from above.

FIG. 14. Section through detector to show arrangement of fluorescent screen, aluminum mirror and 913A multiplier phototube.

Originally we placed the reciprocator below the grid but in order to keep over-all thickness as small as possible and thus allow the assembly to be used in tilt tables, we have moved the reciprocator to the side of the grid. As presently designed and with the electric motors now available to us, the reciprocator is approximately $3\frac{5}{8}$ inches thick and, therefore, projects $\frac{7}{8}$ inch beyond the bottom of the grid. However, the thinnest detector we have been able to devise projects a full inch beyond the bottom of the grid, so nothing would be gained at this time by further refinement in the design of the reciprocator.

CONTROL CHASSIS

A metal cabinet measuring 12 by 12 by $8\frac{1}{2}$ inches contains the Cramer safety switches, twelve small relays, six pilot lights, six fine and six coarse adjustment potentiometers, together with electronic tubes, transformers, condensers, and the other parts that comprise the circuit shown in Figure 1.*

Cramer Safety Switches. Modern roentgen-ray machines are usually provided with built-in devices that limit the maximum exposure time to one that will be safe for the particular voltage, current and tube that is being employed. Such protection is particularly important with phototimers and in the past we have provided it by means of a valve tube and a condenser circuit.[2] It is simpler, however, to employ motor-driven timing devices such as the Type TD1 manufactured by the R. W. Cramer Company of Centerbrook, Connecticut.

When 110 volts A.C. is supplied to the timer motor, an indicator moves counterclockwise until it reaches 0, whereupon a pair of normally closed contacts is opened. When the alternating current supply to the motor is broken, the indicator hand resets, the normally closed contacts close, and the timer is ready to operate again. The time elapsing between the energizing of the motor and the breaking of the normally closed contacts is determined by the zero position of the hand which is controlled by a knob on the face of the instrument.

OPERATION OF PHOTOTIMER

Let us assume, for example, that the phototimer is to be used with a rotating anode tube and a Potter-Bucky grid for Station I (chest) as well as for Station II

* During the temporary absence of one of us (R. H. M.) for service with the United States Public Health Service, we have had the technical assistance of Harold Ticho, M.S., former member of the electronics staff of the University of Chicago. Mr. Ticho's work on the chassis circuits and the calibration of the detector is hereby acknowledged.

(table) and that the station switch has been thrown to Station II and the disc set for stop No. 3. Under these conditions, relay No. 5 closes because its coil receives ground from commutator button No. 3 and 110 volts from the station switch. Relay No. 5 has three pairs of normally open contacts which now close. One pair lights the pilot for stop No. 3, a second pair completes the ground connection to the 1,000 volt transformer and the operating push button, and the third pair completes the high voltage circuit to the resistor network of the Station II phototube through the potentiometers that have been calibrated for stop No. 3.

When the station switch was thrown to II, the Station II grid was set in motion and current was supplied to the starting mechanism of the rotating anode tube so that as soon as the rotor has been brought up to speed (we use a foot-switch for this), the stage is set for an exposure. When now the operating push button is closed, relay No. 12 is energized and its two normally open contacts close. One pair of these contacts carries no current because the Station I tube is not in circuit but the other pair receives 110 volts A.C. from the starter of the Station II tube and delivers it to one side of the Station II Cramer motor and to one side of the coils of relays No. 7 and 8. Since the Station II grid is now in motion, relays No. 7 and 8 are receiving pulses of ground whenever the grid begins travel in a new direction; and with the first of these pulses following the closing of the operating push button, relays No. 7 and 8 close and the number II Cramer motor starts to run. The closing of the No. 7 contacts provides a permanent ground to relays 7 and 8 and the Cramer motor so that these relays remain closed and this motor continues to run as long as the operating pushbutton is held closed.

Relay No. 8 has three pairs of contacts—one normally closed, two normally open. Opening the normally closed contacts takes the short off the Station II condenser, and closing the two pairs of normally open contacts starts the roentgen-ray exposure and puts the Station II thyratron (IC21) in circuit with the coil of relay No. 11. When the thyratron fires, relay No. 11 closes, opening its single pair of normally closed contacts and thus terminating the exposure. If the exposure called for by the phototube is longer than that for which the Cramer safety switch is set, it is the opening of the Cramer contacts rather than the opening of the contacts of relay No. 11 which terminates the exposure.

VOLTAGE-COMPENSATING CIRCUIT

This circuit is shown near the lower center of Figure 1. It is arranged so that raising the voltage at the kilovolt meter of the roentgen-ray machine decreases the sensitivity of the phototimer, while lowering that voltage increases its sensitivity, thus compensating for the effect of voltage change on the amount of radiation absorbed by the rear screen, the back of the cassette and the cover of the detector.

USE WITHOUT GRIDS AND WITH STATIONARY ANODE TUBES

If either station is to be used without a Potter-Bucky grid, it is necessary merely to provide the appropriate relays with a permanent ground, and if either station is used with a stationary anode rather than a rotating anode tube the appropriate contact of relay No. 12 must be supplied with 110 volts directly from the station switch.

CALIBRATION

Station II, Stop No. 2: A patient is placed in position for a roentgenogram of the pelvis with stop No. 2 registered in front of the detector and a 14 by 17 inch film in the tray. The machine is set for any desired voltage and current—for example, 70 kv. and 75 ma.—and the number II Cramer switch is set for the maximum safe exposure as determined by the tube manufacturer's chart. The fine adjustment potentiometer for stop No. 2 is set midway between D and L (D for dark, L for light), and by means of a screwdriver the coarse adjustment potentiometer for this stop is

set at its mid point. The rotor of the Station II tube is now started, the operating push-button closed, an exposure made and the film developed for a standard length of time in developer of standard strength and temperature. If the completed roentgenogram is too dark or too light the coarse adjustment potentiometer is turned slightly clockwise toward L or counterclockwise toward D, the process being continued until the desired density is obtained. By similar means the remaining stops of Station II are calibrated—stop No. 1 for knees, stop No. 3 for lateral lumbosacral spine, stop No. 4 for wrists as well as those of Station II, stop No. 1 for frontal chests, stop No. 2 for lateral chests.

It should be the aim to produce roentgenograms of optimum density for all parts when the fine adjustment potentiometers are at their central points, but to compensate for individual preference as to film density and for minor variation in darkroom technique and in film speed the operator may rotate the fine adjustment potentiometers toward D or L.

When maximum rotation of the fine adjustment potentiometers fails to bring roentgenograms within the desired density range, it is well to check darkroom conditions and the circuits in the chassis before changing the coarse adjustment potentiometers.

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2. MORGAN, R. H. Automatic control of exposure in photofluorography. *Pub. Health Rep.*, 1943, *58*, 1533–1541.
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EVALUATION OF ROENTGEN THERAPY IN FILARIASIS*

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FILARIASIS has assumed military and naval importance because it has interfered with the efficiency of our armed forces. Because of the chronicity of this disease and its resistance to treatment, it has challenged the skill of the doctors responsible for the health of these patients. Since recent reports have encouraged the use of roentgen rays in treating filariasis, we decided to try to establish the value of this treatment.

The purpose of this paper is to evaluate the results of roentgen therapy in filariasis by comparing the course of the disease in a group of 50 patients treated by roentgen rays with that of an untreated group of the same number.

Dickson, Huntington and Eichold[3] were the members of a Filariasis Board created by the Commanding General of the Defense Force, Samoan Group. Their preliminary report states that the lymphangitis of suspected filarial origin in Samoa was seen after only five months or more of duty in that area. The lesions usually started with the lymphadenitis, and then continued as a retrograde or centrifugal lymphangitis. There was a highly characteristic scrotal involvement (Fig. 1) with funiculitis. No cutaneous or urethral infection was seen. There was a tendency to multiple involvement and recurrence. The constitutional symptoms were mild, usually consisting of a little fever, headache, mental sluggishness, anorexia, nervousness, fatigability, and pain in the areas of lymphadenopathy.

In a later report by Huntington, Fogel, Eichold and Dickson,[5] they state that filariasis among American Troops in a South Pacific Island group resembled the clinical entity described by Buxton in 1928 for which he used the native term *mumu*. This disease occurred in Europeans within a few months of their arrival in a filarial region.

It has been established that the observed lesions are caused by *Wuchereria bancrofti*. Filariasis is a nematode infection which is present in tropical and semitropical areas of

FIG. 1. Showing characteristic scrotal involvement.

the world. The Samoan variety occurring in our troops lacks the nocturnal periodicity of microfilariae. In endemic areas where large masses of the native population are infected, the microfilariae may frequently be demonstrated in the blood. One of our patients who was admitted after this study was concluded showed evidence of microfilariae in his blood (Fig. 2). This twenty-two year old male was a native of the Virgin Islands and had probably had *mumu* since the age of five years. He enlisted in the United States Navy several years ago. He was the first filariasis patient with a positive blood smear so far admitted to our hospital. In lymph nodes removed from some of our Service men, Michael[6] has demonstrated the adult female pregnant *Wuchereria bancrofti*. Man is the definitive

* Presented at the Joint Meeting of the American Roentgen Ray Society and the Radiological Society of North America, Chicago, Ill., Sept. 24–29, 1944.

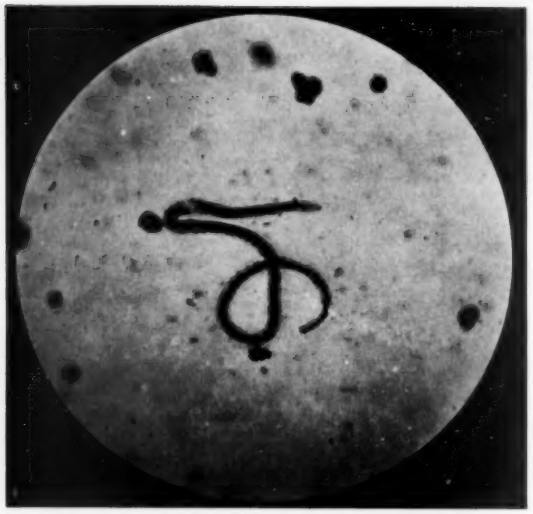

FIG. 2. Photomicrograph showing microfilaria and its fine capsule as seen in a blood smear. This was found in the blood of our twenty-two year old patient who was a native of the Virgin Islands. Note the erythrocytes and leukocytes surrounding the microfilaria.

host and approximately forty-four different mosquitoes may serve as the intermediate host for the development of the mature larvae. Since the circulating blood of those affected, with only the exception of the aforementioned patient, did not show microfilariae, the possibility of transmission of the disease after the patients' return to the United States is thought to be nil. The symptom-free period may vary from two to twelve months. On the average, the first symptoms appear seven to nine months following exposure.

ROENTGEN TREATMENT

The evaluation of any form of therapy for filiariasis is uncertain and difficult because the disease is characterized by spontaneous remissions and exacerbations. It is a subacute and relapsing disease in which the constitutional symptoms form a major part of the clinical picture. We must therefore rely on the patient's story to some extent in evaluating the results of treatment.

Adams[1] in 1908 reported a good result following roentgen treatment in a case of elephantiasis arabum of the upper eyelid of five years' duration. Marked improvement was noted after five roentgen treatments. Other types of therapy had previously been unsuccessful. This patient received a total of twenty-three roentgen treatments. The dosage is not stated except in duration of treatment.

Mitra[7] in 1930 recorded the improvement of an area of chronic brawny swelling on the dorsum of the hand and wrist in a patient with microfilariae in the blood after a series of eight roentgen treatments. These were given over a period of four months. There was no recurrence after six months.

Golden and O'Connor[4] in 1934 made the first comprehensive report of the roentgen treatment of filarial lymphangitis and adenitis. Fifteen unselected cases were given roentgen irradiation over the involved extremity and were followed for eight months to three and one-half years after the first treatment. Eight of these patients appeared to be somewhat improved. In 5, the observed changes were too uncertain to permit judgment, and in 2 patients there was no change in the succession of attacks. In only 1 patient was the size of the enlarged gland reduced.

Their dosage varied. Some patients were treated with 180 kv., with a filter of 0.5 mm. copper; 50 to 75 r was given per sitting every week or every two weeks for four treatments. Others were treated with 130 kv. and a filter of 3 mm. of aluminum, giving 100 r over one field per sitting. When the extremity was cross-fired, half the dose was given on one side and half on the other. Occasionally these authors observed an abortive attack immediately after roentgen treatment, but as the treatment continued the reactions became less marked and finally ceased. Histological sections of irradiated tissues containing worms showed more numerous giant cells in their vicinity. These worms were surrounded by marked round cell infiltration and by fibroblasts, in contrast to slight round cell infiltration and areas of hyalinization about the worms in the sections of unirradiated tissues.

Burhans, Camp, Butt and Cragg[2] more recently treated a group of Navy and Marine patients by roentgen irradiation. Their preliminary report in February, 1944, shows that the results of this treatment are encouraging. Their study does not include a control group of patients. These authors selected patients who had bilateral lymph node involvement and administered roentgen treatment only to one side. This allowed for the untreated side to be observed as the control. They put their patients on outdoor duty after the roentgen treatment to observe the effect of roentgen irradiation on any possible recurrence. They report that after a period of observation these patients developed recurrences on the untreated side and that the disease on the treated side was reduced or did not recur at all. The treatment factors were: 140 kv., 15 ma., 50 cm. target-skin distance, filtration of 1 mm. aluminum and 0.25 mm. of copper; 105 r was given every other day until a dosage of 315 r (including back-scatter) to each area was reached.

Material. All patients included in our study were referred for treatment from the Tropical Disease Section of the hospital.

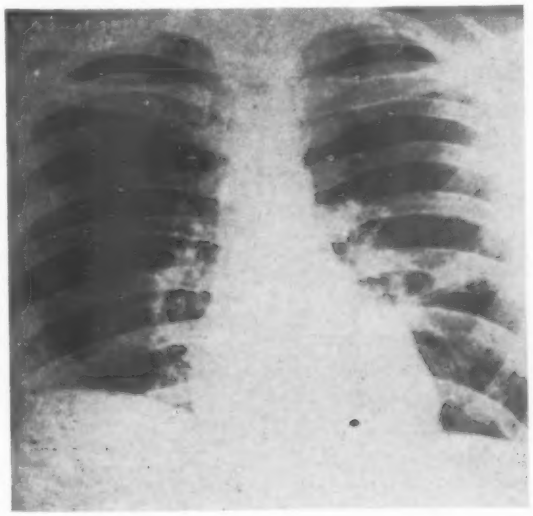

Fig. 3. Roentgenogram of the chest (August 2, 1943) of a patient with filariasis complaining of chest pain. Note patchy and confluent densities at the right costophrenic angle and accentuated left perihilar markings.

Fig. 4. Roentgenogram of the chest of the same patient (September 1, 1943) one month later showing a shift of the density at the right base to a position above the mid portion of the right diaphragm. A zone of increased density is also noted at the base of the right upper lobe.

The diagnosis was established according to the criteria reported by Dickson and his board. Alternate cases were designated as controls and only myself and my assistant knew which patients were actually receiving the treatment. All the patients were under the impression that they were being treated and all were placed under the machine. In the control group the roentgen-ray beam was not used. The referring physicians were asked to make periodic examinations and to record their findings. The patients were all questioned and examined before each roentgen treatment and at weekly intervals after treatment. The findings were carefully recorded.

These patients were white males of the Navy and Marine Corps between the ages of nineteen and thirty-six years who had been sent to the hospital from a South Pacific group. The average time between exposure to the disease and the onset of symptoms was nine months.

The symptoms were tiredness, nervousness, painful glandular swellings, headache, loss of appetite, photophobia and mental sluggishness.

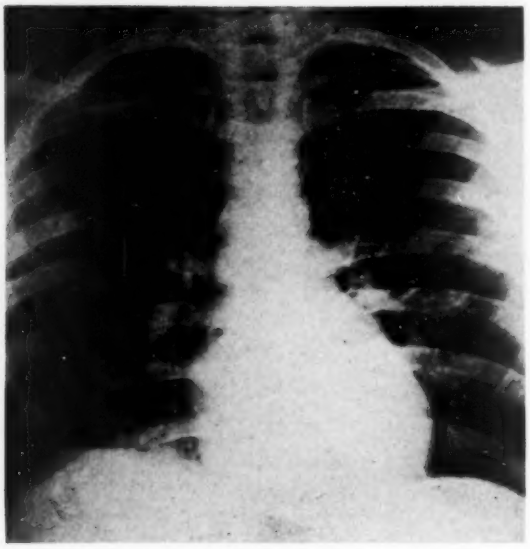

FIG. 5. Roentgenogram of the chest of the same patient (September 6, 1943) five days later shows partial clearing of both densities in the right lung and accentuated pulmonary markings at the base of the left upper lobe.

Some of these patients complained of a pleuritic type of chest pain. Roentgenoscopic and roentgenographic examination

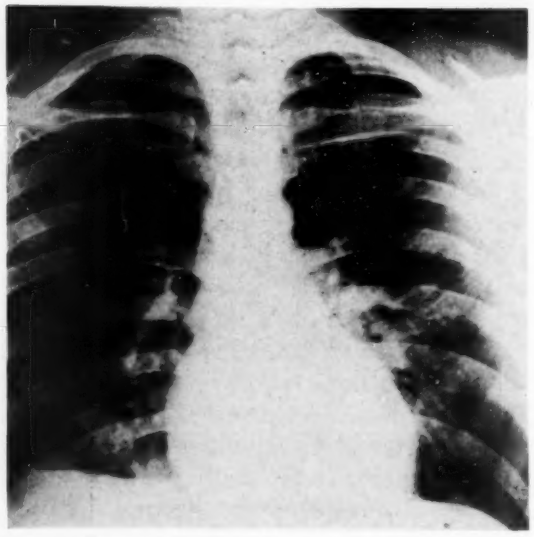

FIG. 6. Roentgenogram of the chest of the same patient (September 13, 1943) six weeks after the first study shows a small patchy density in the right cardiophrenic angle, clearing of the density in the right upper lobe and accentuation of the left hilar shadow and perihilar markings.

of the chest (Fig. 3, 4, 5, 6 and 7) showed a patchy type of parenchymal infiltration as evidenced by a mottled increased density affecting one or more lobes of one or both lungs. These areas cleared spontaneously in one lobe only to reappear in another lobe of the same lung or in the opposite lung. There were none of the signs or symptoms which usually accompany an atypical pneumonia. The patients were afebrile and the blood counts were within normal limits. The lesions were observed over a period of

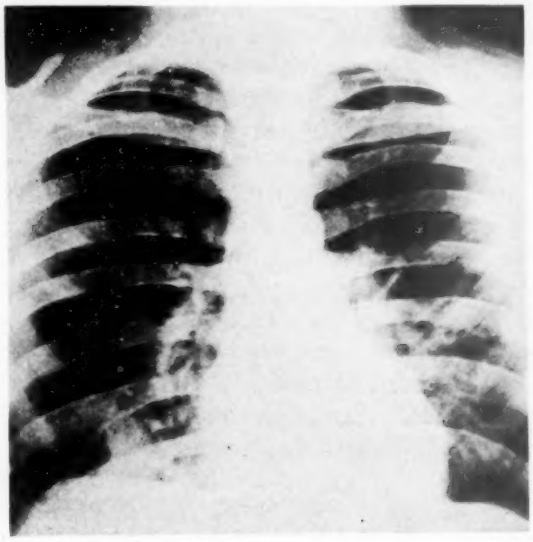

FIG. 7. Roentgenogram of the chest of the same patient (September 27, 1943) almost two months after the first study shows a more pronounced patchy and confluent increased density in the right cardiophrenic angle and more marked peribronchial infiltration adjacent to the left heart border.

months. One area would clear in several weeks while others would persist for months. While one area cleared, a new area in another lobe might appear. None of these patients were acutely ill at any time.

The physical signs were multiple cervical, axillary, epitrochlear and inguinal adenopathies, usually tender on palpation and measuring 0.5 to 2 cm. in diameter. Other signs were a thickened epididymis, enlarged testicles, hydrocele and varicocele. Occasionally a thickened cord-like struc-

ture was palpable in the soft tissues of the extremity. True red streaks on the extremities were rarely seen. Edema of the forehead and face and moderately swollen extremities were sometimes observed. No cases of true elephantiasis were seen. All of these patients represented very early cases of filariasis. Only a few had a low grade fever. All were ambulatory, well nourished and did not appear acutely ill. Blood smears during the day and night showed no evidence of microfilariae.

The treatment consisted of both intermediate and deep roentgen therapy ranging from 135 to 250 kv., 15 ma., 50 cm. target-skin distance, and 0.5 mm. copper plus 1 mm. aluminum filter. The treatment was directed to the areas of adenopathy and/or to the areas of localized swelling of the extremities. The size of the field was usually 10 by 15 cm. over the gland-bearing areas, such as the axillary, inguinal, and femoral fields. The epitrochlear areas treated were usually 6 by 8 cm. in size. In addition, we gave a course of treatment to some patients over the hypogastric gland areas through a 15 by 20 cm. lower anterior abdominal field.

The dosage was 150 r, measured in air, given to one area every two days for three treatments until each area received 450 r.

Since some authors believe that the adenitis and lymphangitis are local manifestations of an allergic response to the worm protein, another group of patients was given total body irradiation in an attempt to determine the effect of roentgen rays on the total organism. The factors for this treatment were: 250 kv., 15 ma., 135 cm. target-skin distance, and 0.5 mm. copper plus 1 mm. aluminum filter; 10 r, measured in air, was given to each of two anterior fields and two posterior fields per sitting which together covered all of the body except the head. Three such treatments were given at intervals of two days. The blood count was checked before each treatment and only a few patients showed a slight leukopenia. In these, the treatment was postponed for several days until their white blood count returned to a normal level. The response to the total body irradiation was similar to that observed after the administration of local therapy except that the glandular swellings did not regress as markedly.

It was interesting to note that there was a marked psychic factor in the patients' evaluation of the treatment. Several patients who were placed under the roentgen machine as controls reported that their symptoms were aggravated by the "treatment." They thought their glands were more painful and larger and that their headaches were more frequent and more severe. Some complained of nausea. A few of the patients who were actually treated had similar complaints. In 1 patient, there was a noticeable enlargement of his inguinal glands after the first treatment but no flare-up occurred after the second and third treatments. This patient had the most marked regression of his adenopathy following completion of treatment. Golden and O'Connor report a similar experience in 1 of their cases.

The patients were examined at weekly intervals after the completion of treatment for a period of six to eight weeks and then at monthly intervals whenever possible. Many continued to have some complaints. A few thought they felt better and had less pain. Some thought that they were less sluggish and felt brighter. These changes were noted by patients in both the treated and untreated groups.

Most of the patients in this study have been followed for a total of three to four months after treatment.

Results. About 19 to 20 per cent of the patients treated by roentgen rays now are free of disease. A slightly higher percentage of the untreated or control group are free of disease as determined by physical examination. One must conclude therefore that the disease as a whole is not materially affected by roentgen therapy as observed three to four months after treatment. We did observe some beneficial effect in reducing the size of the enlarged lymph nodes and re-

lieving some of the pain which accompanies these glandular swellings. There were no cases of suppurative adenitis in this series.

Our experience with the roentgen treatment of this group of 50 patients suffering from filariasis is not as encouraging as that reported by other authors. A subsequent detailed follow-up study of all patients in this series will be made and reported about one year after the completion of roentgen therapy. Roentgen treatment did not influence the chronicity of the disease nor did it affect the frequency or severity of the periods of exacerbation following the periods of remission.

CONCLUSIONS

1. The course of filariasis as observed in 50 patients treated by roentgen irradiation and in 50 untreated patients is similar when examined three to four months after treatment.

2. Several patients have derived benefit from roentgen therapy in that some glandular swellings were reduced in size and were rendered less painful.

3. No harmful effects were observed as a result of this roentgen treatment.

4. Total body irradiation offers no advantage over local roentgen therapy, and at times does not appear to be as effective in relieving the pain of enlarged glands or in reducing their size.

5. Roentgen therapy did not influence the frequency, duration, or severity of recurrent attacks after periods of remission.

6. The roentgen appearance of the chest of several patients who complained of a pleuritic type of pain is presented. The lesions found were a transitory and migrating type of chronic pneumonitis affecting one or both lungs. These patients were afebrile and showed a normal white blood cell count.

7. A further follow-up study will be made one year after the completion of roentgen treatment.

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DISCUSSION

Colonel A. A. de Lorimier, M.C., Memphis, Tennessee. It is my understanding that I was named to start this discussion as an Army representative—possibly because it was thought that Dr. Jaffe, representing the Navy, was going to be overenthusiastic about his results. However, he wasn't so very enthusiastic and perhaps there is no reason for my discussion.

Theoretically there might be three means by which radiation therapy might obtain results in the treatment of filariasis. It might sterilize the parasite and thereby minimize the task of destruction of all contained. It might directly destroy the parasite, or it might intensify reaction on the part of human tissues.

Of these three possibilities, it would seem that the first two can be dismissed almost immediately. The parasites are prone to circulate or at least migrate. Therefore, local treatment cannot be expected to sterilize or destroy all of them.

Dr. Jaffe applied the total body irradiation in small dosages, seemingly too small to destroy these organisms and likely too small to sterilize them. Still, he was rightfully apprehensive about white blood cell depletion of the patient.

Thus we are left to consider the practicality of roentgen therapy directed for tissue reaction. The observations of Dr. Jaffe as well as those by Golden and O'Connor and by Burhans and his co-workers are not encouraging but they

are no more discouraging than are the observations following medicinal treatment. Apparently we have no satisfactory regimen for medical treatment of this disease.

With rest and ideal hygienic conditions, the organisms eventually die and become calcified.

As mentioned by Dr. Jaffe, it is possible that the mumu stage of this condition—the lymphadenitis and lymphangitis—is of an allergic nature. It is not satisfying to hear discouraging comments such as we have heard. However, we must know of our limitations.

Certainly Dr. Jaffe is to be congratulated for his scientific approach to this study and for his straightforward thinking and advice.

It is quite likely that all of us in the future will be seeing cases of this sort as our service personnel return from filariasis infested regions —the islands in the Pacific, Africa, India and South China.

We must not speak too enthusiastically as to the possibility of the benefits of roentgen irradiation, of course.

I would be very eager to hear further comments from Dr. Golden.

Dr. Ross Golden, New York. I wish to compliment Dr. Jaffe highly on his very careful, unbiased and scientific approach to the problem. It is quite apparent, however, that his cases were in quite a different stage of the disease from those we saw.

The late Dr. Francis W. O'Connor, Professor of Tropical Medicine, College of Physicians and Surgeons, spent a number of years in the South Pacific studying filariasis. What little I know about filariasis I learned by word of mouth from him. As you know, when these parasites die, some of them become calcified and the shadows of the calcified dead organisms can be shown in the subcutaneous tissues of the lesion, in the popliteal lymph nodes and in the scrotum. O'Connor, Auchincloss and I published a paper in 1930 on the demonstration of calcified filariae. It would be very interesting if Dr. Jaffe and his co-workers in the Navy could follow the evolution of these organisms, to see when this calcification can be demonstrated. Dr. O'Connor thought that this is a helpful diagnostic measure in some cases.

When an infected mosquito bites its victim, the organisms drop off the mosquito's snout and go through the skin into the subcutaneous tissue. Many of them stay in the subcutaneous tissue and develop into adult worms which are 4 or 5 inches long and which look like a dirty linen thread. Some of the organisms get into the lymphatics and may be stopped in the popliteal or inguinal lymph nodes.

In the West Indies and in some parts of the world the mosquitoes which carry this infection are low fliers; that is, they fly close to the ground and therefore they bite the ankles. When a man squats down they may bite and infect his scrotum and thus he may get scrotal elephantiasis.

In other parts of the world they fly higher and bite the arms. *Filaria loa*, endemic in Africa, is usually seen in the arms. We treated 3 such cases.

The victim of filariasis may have no symptoms or very minimal symptoms for some time, and then attacks of what is known as filarial lymphangitis occur. They usually begin in one spot which O'Connor used to call the focal spot. It may be on the leg, it may be in the groin, it is sometimes in the scrotum. A red spot appears with local pain; the redness rapidly extends up and down the leg; the patient has violent constitutional symptoms, vomiting, high fever, generalized pain; sometimes even unconsciousness. We had one patient who spent three weeks out of every month in bed on account of these constitutional symptoms resulting from filarial lymphangitis.

O'Connor found that sometimes the recurrence of these attacks of filarial lymphangitis could be stopped by excising the focal point and in that focal point he would invariably find a live worm. In 1928, he asked whether roentgen treatment might possibly alleviate this condition by interrupting the sequence of these attacks. He believed it was worth trying as nothing else could be offered except excision of a focal point in an occasional case, or an extensive resection of the subcutaneous tissues in elephantiasis. He also wondered whether the elephantiasis might be reduced, which actually occurred in only one of our cases. He inquired also about trying roentgen therapy in chyluria. This led to the treatment of the series of cases which Dr. Jaffe recounted. Since O'Connor's untimely death about five or six years ago, we have had no additional cases, as he was the attraction which brought these patients to the hospital. It should be emphasized that our cases had the disease for many years at the time we saw them and most of them had a marked enlargement of the legs. In thinking of the

roentgen treatment of this condition, it must be borne in mind that the organisms in the blood are microfilariae, which are the offspring of the adult worms and have nothing to do with the symptoms. The adult worms lie in the subcutaneous tissues of the legs and in the lymphatics. Patients may have violent filarial lymphangitis without having microfilariae in the blood.

Two theories in regard to these filarial attacks are held. One has already been mentioned, that is, that the disturbance is a sort of allergic reaction. It was O'Connor's opinion that the attacks were caused by the worm itself. The other opinion, emphatically supported by some workers, is that the attack results from a secondary infection. In favor of that theory are the results of some experiments done by Homans and Drinker in Boston. They produced elephantiasis in dogs' legs by injecting silicates into the lymphatics. Some of those dogs with enlarged legs got attacks similar to filarial lymphangitis. It is my impression that the prevailing opinion now is that the attacks are caused by the worm.

In many cases the sequence of attacks is interrupted when the patient goes from a hot to a cold climate. On the contrary, we had one patient in whom the reverse occurred. He got the infection in Africa. At his home in Canada, when the temperature got low he would have an attack. The series of roentgen treatments he received seemed to interrupt them. He then got along for at least a couple of winters without attacks.

We had some cases in which chyluria stopped following roentgen treatment. I do not know whether the roentgen treatments were responsible or not, but the coincidence was quite definite, and seemed to make the treatments worth while. In these cases I believe it is worth while to try the treatment of the kidney and, if cystoscopy shows enlarged lymphatics in the bladder wall, to include the bladder region.

In the chronic cases with recurring lymphangitis, there is little to offer the patient unless the new bactericidal drugs may be found effective. It seems to me worth while to try roentgen treatment with particular attention to the focal spot.

Again I wish to compliment Dr. Jaffe and to express the hope that the medical officers of the Army and Navy will seize this opportunity to continue the study of this very peculiar disease.

LIEUTENANT JAFFE (closing). I want to thank Colonel de Lorimier and Dr. Golden for their kind remarks and very fine discussion.

The mental attitude of patients with filariasis is important. These boys are depressed and worried about their future. They have heard stories about elephantiasis developing in later life and fear that their testicular swelling may lead to impotency. These findings have not been observed to date and it is possible that the early cases of filariasis may recover completely without sequelae or complications.

The Navy has found that these patients who are ambulatory and not acutely ill do better when given some form of duty. Their mental attitude improves when they are treated as normal people rather than patients. A camp has been established where the filariasis cases are given light duty and are grouped together for further study and treatment. Civilian as well as military and naval physicians should encourage these patients and not be too pessimistic about their ultimate recovery.

We kept the dosage for the total body irradiation low because we did not find microfilariae in the circulating blood and therefore had no reason to employ larger doses.

Dr. Allen of Kansas City suggests that the lung changes observed in our patients may be similar to Loeffler's syndrome which is an allergic manifestation of intestinal parasites causing a transitory parenchymal infiltration of the lungs.

DIRECT AND INDIRECT RADIOTHERAPY*†

By B. GRYNKRAUT (of Warsaw)
Doctor of the University of Paris

SINCE 1929 when I worked out and published the actinic theory of cancer[1,2,3] I have been able to verify it by many experiments and in this way to bring about a certain amount of progress in the treatment of malignant tumors. I was led to develop this theory by the difficulties of the radiotherapist who has to deal sometimes with tumors that are radiosensitive and disappear readily under the action of radiotherapy, and sometimes with radioresistant tumors, which are less sensitive to roentgen rays or radium and who cannot find any sufficient reasons to account for this difference. Since the chemical composition of radiosensitive and radioresistant tissue is the same, there is no valid reason why roentgen rays should behave especially differently in the two cases. The solution of the problem is not advanced by invoking the physical phenomena which accompany the bundle of rays on its passage through the tissue, as the same phenomena are seen in both cases. Whether it is a radiosensitive or a radioresistant tissue, the roentgen ray which strikes an atom of tissue produces secondary rays, the wavelength of which is generally greater than that of the incident ray, and detaches electric particles from the atom, electrons called recoil electrons (Compton effect). At the same time the effects of ionization are observed. It might be possible to find in these facts a physical explanation of radiosensitiveness, except that unfortunately these phenomena are seen in radiosensitive as well as radioresistant tissues, absorption being the same in the two cases and depending only on the physical condition and chemical composition of the tissue traversed. Therefore we must have recourse to other properties of the atom and of the radiation which have unfortunately been neglected, and which I have tried to bring to light in the actinic theory of cancer.

One of the fundamental properties of light, of which roentgen rays are only a variant, is that they are disseminated in a straight line and perpendicular to this direction, following the vibrations of electromagnetic waves. In order to accomplish any work, this vibratory energy must be absorbed and assimilated. Now, one necessary preliminary condition to the absorption of vibratory energy is to encounter resonance in the system of the irradiated atom: the atom must vibrate in unison with the light. Just as a given sound can only make a single cord in a piano vibrate, though it strikes many cords all of the same chemical composition and which vary only in their respective lengths, so a wavelength, a quality of a light wave which represents a definite number of electromagnetic vibrations, produces resonance only in those atoms which vibrate easily in unison with this number of vibrations. Therefore in order for the luminous energy of the roentgen rays to accomplish a definite useful work they must fulfill a certain preliminary condition. This condition is fulfilled when the number of vibrations of the roentgen ray which strikes the cell is able to produce in the cell nucleus, in its chromatic network and its achromatic bundles, the phenomenon of resonance: the cell is then said to be radiosensitive. This phenomenon of resonance is accompanied by another phenomenon, that of fluorescence. The emission of a light with a resonance of a greater wavelength than the incident radiation is the characteristic phenomenon of

* The experimental and clinical part of this work was carried out in the following institutions: Histological Institute of the University of Warsaw, Director Prof. Konopacki: Central Institute of Radiology of the Infant Jesus Hospital at Warsaw; Director Dr. J. Sitkowski. Private Institute of Radiology of B. Grynkraut at Warsaw. At present it is being done in Rio de Janeiro, Brazil, where the work was presented as a lesson in a course on oncology. This lesson was given by Prof. Manoel de Abreu.

† Translated from the French by Audrey G. Morgan, M.D., Medford, Oregon.

fluorescence. This phenomenon is accompanied by the absorption of an atom of oxygen. Therefore, in the last analysis the anaerobic mode of life of the radiosensitive cancer cell is struck by the phenomenon of oxidation. We may say, therefore, that resonance and fluorescence form the essential mechanism of the adaptation of the number of light vibrations to a special condition in which it becomes assimilable by the cell nucleus. This luminous energy assimilated and absorbed by the cell is without doubt mitogenetic in nature, that is to say it is able to stimulate the phenomenon of karyokinesis. The mitogenetic light described by Alexander and Lydia Gurwitsch of Moscow is found in the ultraviolet part of the spectrum and is emitted by cells which are undergoing division. It produces, accelerates and destroys karyokinesis. Between the wavelength of a radiation emitted below 200 kilovolts and that of ultraviolet light what a long distance to travel, how many changes to undergo before being able to act on a cell! We may call these substances which transform light by fluorescence sensitizing substances. We find similar substances in the photographic plate and they are the ones which make instantaneous roentgenography possible by better utilization of the light. The presence of such substances *around* the cells would make the cells radiosensitive and their absence would make them radioresistant. I emphasize the word "around" for these substances are necessarily pericellular, as the quality of radiosensitiveness is not inherent in the cell. As a matter of fact,

(a) Any cell cultivated outside the body becomes radioresistant. A tissue culture only becomes sterile (its nuclei not being able to divide, though the protoplasm can breathe and be nourished) with a single dose of 25,000 r of very hard or very soft rays[4,5] while the organism from which the tissue came can be killed by a much lower dose. A single dose of 1,080 r kills a young rat twenty days old in six days (Grynkraut and Flaks[6]) or a dose of 1,500 r kills an adult rabbit in eight days (Grynkraut and Sitkowski[7]).

(b) The irradiation of radiosensitive tumors with repeated but insufficient doses makes the tumor radioresistant (Bergonié). And yet the irradiation has not changed the histopathological type of the tumor. What has happened in these cases after repeated irradiations is that the sensitizers to light have been destroyed and it has not been possible to reconstruct them.

(c) Metastases of radiosensitive tumors may become radioresistant or, on the contrary, radioresistant tumors may give rise to radiosensitive metastases. What has changed in these cases has been the external conditions in which the metastatic cells may become radiosensitive if they find radiosensitizing substances.

(d) If the action of roentgen rays in therapeutic doses has to undergo preliminary changes before beginning to act on the cell itself the action is indirect and mediate. We have tried to make this indirect action manifest in the following experiment carried out in collaboration with Flaks.[6] In this experiment, rat A, twenty-five days old, had had a Jensen sarcoma for fourteen days. This tumor was incised twice in two different places, once before irradiation and again after irradiation. On each of these incisions bits of the tumor were removed which were then grafted. The first time the tumor was incised, two particles were removed and each piece was inoculated into the gluteal muscles of a rat seventeen days old—rats No. 1 and 2. The wound was then closed. These were control rats inoculated with non-irradiated grafts. In the second stage the rat A was subjected to general irradiation with a lethal dose of roentgen rays. The rays were only slightly filtered (1 mm. wood) but the radiation was quite penetrating (176 kv., 2 ma.), and the focal distance 30 cm. A dose of 1,080 r was given in twenty minutes. After an hour another incision was made in the same tumor and three grafts removed from another part of it. These fragments

were grafted into the thigh muscles of three fresh rats seventeen days old (No. 3, 4 and 5), and of the same litter as the control rats. These last grafts, therefore, came from a tumor that had been irradiated.

On the twentieth day of the experiment we found that:

(a) All the grafts without exception took (both the irradiated and the non-irradiated).

(b) They produced tumors weighing 6 gm., 5 gm. and 8 gm. in the control cases (average 7 gm.) and 8.5 gm., 9 gm. and 13 gm. (average 10 gm.) for the tumors originating from grafts of a tumor that had previously been irradiated with a lethal dose.

(c) As to macroscopic metastases in the lumbar glands at the bifurcation of the aorta, they were well developed in the rats inoculated with the grafts that had been irradiated previously and were still invisible in the control cases. This experiment was presented before a session of the Society of Biology of Warsaw on March 27, 1936.[8]

TABLE I

EFFECTS OF AN IRRADIATION ON THE LATER DEVELOPMENT OF A TUMOR OUTSIDE THE BODY

Rat A, 25 days old; initial tumor Jensen's sarcoma 14 days old		
(a) First incision on non-irradiated tumor, 2 rats 17 days old were grafted	Weight of secondary tumor on 20th day	Metastases
Control rat No. 1	6.5 gm.	
Control rat No. 2	8.0 gm.	Absent
(b) Second incision of the same tumor 1 hour after irradiation with a lethal dose		
Rat No. 3	8.5 gm.	
Rat No. 4	9.0 gm.	Apparent
Rat No. 5	13.0 gm.	

As a result of a lethal dose of roentgen rays, the animal survived only a few days and then died. Was the same thing true of the tumor cells which at the time of the irradiation were a part of the body of the rat and which were also subjected to the action of the rays? The answer is No. The tumor tissue remained insensitive to the irradiation and in a new medium in another rat it developed readily. The action of the rays at this dosage was not direct, as it left the tumor cells intact and capable of later development. The action of the rays in this case was therefore indirect; it was brought about by the intermediation of sensitizers which reduced the light by fluorescence, creating luminescence more capable of being assimilated by the cell nucleus. Thanks to this fact a dose one-twentieth of that necessary for direct action (25,000 r), that is a dose of 1,080 r, was fatal to the body of the rat.

(d) The nature of the indirect dose is shown by the experiments which follow. If the irradiated tumor is left for a long enough time in the body of the irradiated animal, its vitality decreases visibly and the decrease is greater the longer the transfer is delayed.

Description of the Experiment:

On January 8, 1938, three rats twenty-five days of age with large tumors (Jensen sarcomas) were irradiated. The weights of the rats including the tumors were at this date for rat C 68 gm., for rat D 90 gm., and for rat E 91 gm.

(1) January 8, 1938. Rat C was killed two hours after irradiation with a lethal dose. The weight of the tumor was 10 gm. Five other rats (weights 100 to 120 gm.) were grafted intramuscularly with bits of this tumor.

(2) January 10, 1938. Rat D was killed forty-eight hours after irradiation with a lethal dose. The weight of the tumor was 9 gm. Bits of this tumor were inoculated into 5 rats (weights 90 to 110 gm.).

(3) January 11, 1938. Rat E was about to die seventy-two hours after irradiation with a lethal dose and was killed. The weight of the tumor was 15 gm. It was inoculated into 5 rats (weights 100 to 110 gm.).

(1) On January 21, 1938, that is thirteen days after being grafted with the tumor of rat C, the 5 rats grafted with it were killed.

The weights of the tumors obtained in this way were 0.7 gm., 0.4 gm., 0.5 gm., 0.65 gm., and 1.2 gm., total weight 3.45 gm.

(2) On January 23, 1938, the 5 rats inoculated with tumor D were killed. The weights of the tumors thirteen days after inoculation were 0.5 gm., 0.9 gm., 0.4 gm., 0.5 gm. and 0.6 gm., total 2.90 gm.

(3) On January 24, 1938, that is thirteen days after having been grafted with the tumor of rat E, the weights of the tumors obtained from the 5 other rats were 0.6 gm., 0.1 gm., 0.2 gm., 0.25 gm., 0.25 gm., total 1.40 gm.

TABLE II

IMPORTANCE OF THE "TIME" FACTOR IN THE INDIRECT ACTION OF ROENTGEN RAYS. THREE RATS WITH LARGE JENSEN SARCOMAS WERE IRRADIATED WITH THE LETHAL DOSE

Rats with primary tumor	Time after irradiation	Weight of primary tumors
C	2 hr.	10 gm.
D	48 hr.	9 gm.
E	72 hr.	15 gm.
Grafted on 5 fresh rats	**Date killed**	**Total weight of secondary tumors**
Jan. 8	Jan. 21	3.45 gm.
Jan. 10	Jan. 23	2.90 gm.
Jan. 11	Jan. 24	1.40 gm.

A tumor which remains in an irradiated medium dies there; however, if the medium is changed it may develop later, but only on condition that it has been removed from the first medium soon enough. The sensitizers of the irradiated medium, therefore do not adhere to the cell as they do not accompany it into the new medium. The time factor therefore expresses the intensity of the indirect dose.

(e) The effects of indirect irradiation[9] may be studied on young rats fifteen to twenty days old which have been given a single total irradiation. Half of the lethal dose applied in this way allows the animal to survive for quite a long time and causes epilation, profound anemia and atrophy of lymphoid tissue (spleen, lymphatic glands). From our protocols of 150 animals we have chosen the following example which we will describe in more detail.

This experiment No. 4 dated January 5, 1933, was made on 6 rats of the same litter twenty-three days of age and with an average weight of 18 gm. They were totally irradiated a single time with half the lethal dose. Three days later intramuscular grafts of Jensen sarcoma were made into the muscles of the left thigh. On the same date 6 other rats of the same age and the same litter were inoculated in the same way without preliminary irradiation. They served as controls. At the end of five days the weight of the latter had increased an average of 5 to 6 gm., while the former group had kept their initial weight with almost no increase. At the end of ten days the rats that had been given preliminary irradiation had gained an average of 8 to 10 gm., while the controls had gained 13 to 15 gm. On the twentieth day the experiment was ended and the animals were killed. They were then weighed. It was found that the weight of the irradiated rats was less than that of the controls. As to the weights of the tumors that developed on the irradiated rats (1.5 to 4 gm.) they were less than half those of the controls (5 to 8.5 gm.). At this date metastases were found in the lumbar glands only in the irradiated animals while they were still absent in the controls.

The preliminary irradiation of an animal makes it impossible for a graft to grow in it even three days after the irradiation. The graft finds a resistance in the tumors irradiated three days previously, a resistance which is stronger against the growth of the tumor than against the growth of the body of the young rat. The average weight of the non-irradiated animals on the twentieth day of the experiment was 40 gm., that of the irradiated 30 gm. Therefore the irradiation had caused an arrest of growth of 25 per cent in the rats while it had produced a much more powerful arrest of the growth of the tumors. The total weight of the tumors which had grown on the non-irradiated animals was 29.5 gm., while that of

the tumors which had grown on the irradiated animals was only 11.5 gm. Therefore, while the growth substances of the body had suffered a reduction of 25 per cent, the forces which favored the growth of the tumor had been decreased by 60 per cent. The forces which make a young body grow are therefore different from those that make a tumor grow.

Another conclusion is that prophylactic irradiation makes the organism more resistant to tumor growth, but the action of the irradiation must not go so far as to destroy the lymphatic system, as in that case the destroyed glands would become the site of metastases.

In summary, we have looked for and found in our experiments a confirmation of our theory that the tumor cell is in itself radioresistant and becomes radiosensitive only by the pericellular accumulation of substances that are sensitizing to roentgen light. The effects of radiotherapy are indirect, direct effects being manifested only when very large doses are used, such as those used, for example, by Chaoul in his close roentgen therapy. These large doses can be borne, not because of the superficial action of the slightly penetrating rays, as Chaoul thinks, but because only very small fields are irradiated. I have analyzed these phenomena in several publications.[7,10]

The actinic theory in addition to the time factor shows the importance of the space factor and that the irradiation of a large skin surface means the activation of a larger amount of sensitizers. Mallet uses this method of irradiating large fields at a long distance in teleradiotherapy to cleanse the organism of the metastatic disseminations of cancer. He has reported a certain number of successes, on condition, however, of using only very small doses, not exceeding a few multiples of 10 r applied at one sitting. It is evident that with this method the action can only be an indirect one. The irradiation of large surfaces cannot be combined with the use of large doses. On the other hand, though the method of using very small surfaces makes it possible to give large doses of roentgen rays, the percentage of depth transmission is negligible in proportion to that obtained by irradiating large skin surfaces. In order to

TABLE III

EFFECTS OF PROPHYLACTIC IRRADIATION ON THE GROWTH OF YOUNG RATS AND ON THE WEIGHT OF THE TUMORS

Jensen sarcomas were grafted into

(a) Non-irradiated rats

Dates	Jan. 5	Jan. 10	Jan. 15	Jan. 25	Jan. 25	
Rats	Weights				Tumors	Metastases
No. 1	18.5 gm.	24.5 gm.	33.0 gm.	42 gm.	8.0 gm.	absent
No. 2	18.5	24.5	32.0	43	8.0	absent
No. 3	18.5	24.0	32.0	40	8.5	absent
No. 4	19.5	24.5	31.5	35	5.0	absent
No. 5	17.5	23.0	30.5	+	Very small	absent
(b) Irradiated rats						
No. I	19.0	20.5	27.0	—	—	absent
No. II	18.5	20.0	28.0	26	3.0 gm.	macroscopic
No. III	18.0	18.0	26.0	—	—	absent
No. IV	18.5	20.5	28.5	33	1.5	absent
No. V	20.0	20.5	27.5	32	4.0	macroscopic
No. VI	16.5	16.0	23.5	24	3.0	macroscopic

Non-irradiated rats: Total weight of tumors obtained 29.5 gm.
Irradiated rats: Total weight of tumors obtained 11.5 gm.

balance the disadvantages of these two systems, I tried a new solution of the problem and divided the large irradiated field like a checkerboard of small quadrilateral fields 3 by 3 cm. in size, separated by strips of non-irradiated surface covered with lead strips 0.5 cm. wide and 2 mm. in thickness. This can be accomplished easily by taking a sheet of lead 2 mm. thick and making quadrilateral holes 3 by 3 cm. in it and at equal distances of 5 mm. from each other. This grill is fixed to a thin layer of aluminum which is applied directly to the skin. While 1,500 r applied directly without a grill to the abdomen of a rabbit, filtered with 1 mm. aluminum, with 100 kv., or with 1 mm. copper filter and 200 kv., would cause death of the rabbit within eight days, the same dose applied through a grill, and measured under the grill, has no marked effect. Even a double dose of 3,000 r applied all at once through a grill, and measured under the grill, does not cause death until the end of three weeks. Moreover, our experiments show that a so-called "erythema" dose measured under the grill (for the grill partially arrests the rays) and applied to the skin of a man's back on one side, say the right, does not cause the vasomotor phenomena which are seen on the left side where the same dose has been given directly on the skin without the interposition of a grill. The presence of a grill therefore prevents the vasomotor phenomena of erythema, but does not prevent the absorption of the active dose of roentgen rays and therefore makes it possible to increase the intensity of the treatment which is interfered with considerably by the secondary vasomotor phenomena. Similar results have been attained by compression of the skin and by the application of ice which causes anemia of the skin. In our method, the capillary circulation of the skin is kept normal by an entirely different mechanism which we shall describe.

The irradiation of the skin by roentgen rays produces catabolic substances, among them histamine, which must be absolutely eliminated from the irradiated field. This is easy when the field is only a few square centimeters in size, for the return circulation takes place through the intact capillaries of the non-irradiated field bordering the irradiated surface. But if the same surface is included in a larger field which has also been irradiated intensely, the flow of these catabolic substances through the irradiated portion takes place only with great difficulty. It is easy to prove that the surface bordering this large field is relatively smaller than the surface bordering a small irradiated area. For instance, a surface 1 sq. cm. in area would be surrounded by 8 sq. cm. of non-irradiated surface if the non-irradiated bordering surface is 1 cm. broad. The same width of non-irradiated boundary surface bordering 100 sq. cm. of irradiated area would be only 44 sq. cm. Therefore when the irradiated surface increases from 1 to 100 sq. cm. the bordering surface only increases six times (from 8 to 44 sq. cm.). A large irradiated surface has a relatively small boundary surface and the dose of roentgen rays borne by it would be lower because the flow of vasodilator substances from the erythema takes place with greater difficulty and it is therefore relatively more radiosensitive than a small surface. The grill creates a drainage through a large irradiated field which facilitates the nutrition of the small fields and increases their radioresistance (Fig. 1). We made the following experiment: A grill was placed parallel to and above the photographic film, the distance between them being 10 cm. Roentgenography of the grill showed very definite boundaries on the photographic film. But when water was placed between them instead of air the secondary radiation emitted by the water during roentgenography gave an indistinct and not very clear image. This image corresponded to the deep action of the roentgen rays where there are not as distinct zones of separation between the irradiated and non-irradiated surfaces as on the surface of the skin. The action of the grill is therefore different on the surface of the skin and in the deep tissues: it desensitizes the skin and does not

prevent hyperemia of the tumor, which becomes sensitized to the roentgen rays. I irradiated a large number of these patients by the grill method, in collaboration with Sitkowski; one of these cases was published by us in 1939 in Warsaw. It was that of a young man twenty years of age, cachectic, icteric, with a large hard lobulated tumor in the epigastrium. Exploratory laparotomy showed that it was a tumor of the liver, which was confirmed by histopathological examination. The abdomen was closed and the patient was sent by the surgeon to the roentgen department. We gave the radiation through a grill with excellent results; the tumor disappeared and the patient was able to eat and to move without fatigue.

Summarizing we may differentiate between:

(a) Direct radiotherapy—that in which 25,000 r can be applied at one sitting. It is evident that this technique cannot be realized in practice. Only very small fields can bear very large doses of roentgen rays, as in Chaoul's method.

(b) Indirect therapy is that which applies very low doses to very large surfaces, that is, teleradiotherapy which has a purely humoral action. It is of advantage to give these treatments through a grill.

(c) Mixed radiotherapy is carried out partly by the direct and partly by the indirect method: it is the classical radiotherapy with medium-sized fields. It is necessary, therefore, that an effort be made to increase the sensitizing action of the pericellular substances. This sensitization of the tumor is a problem for future research and should be carried out in conjunction with desensitization of the skin, which can be accomplished by the application of grills with square openings or with parallel slits of the Lysholm type. The other conclusions of the actinic theory of cancer cannot be given here and the reader must be referred to our previous publications.[1,2,3] We may add, however, that the actinic theory of cancer holds that the origin of every cancer cell is to be found in a pathological accumulation of growth substances with a photosensitizing function around a diseased cell. On the other hand, in every precancerous

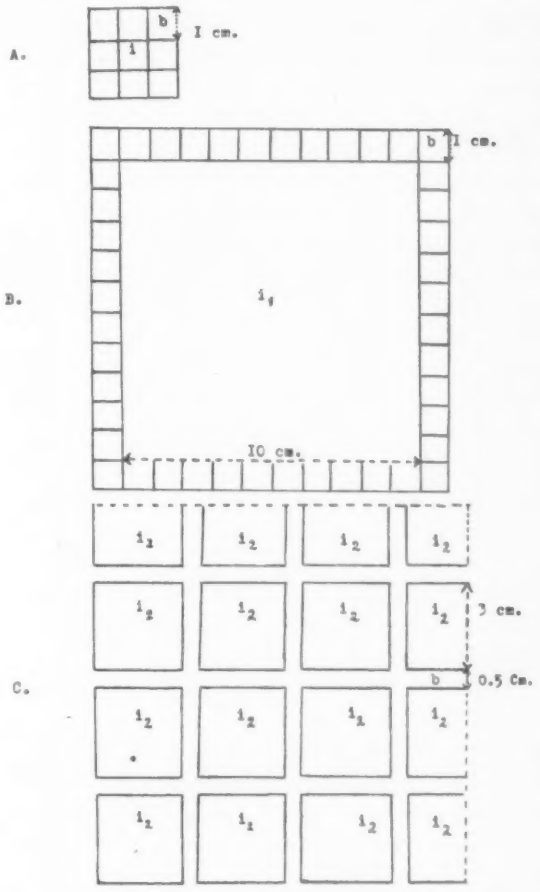

FIG. 1. The respective dimensions of the bordering surface (b) and the irradiated surface (i) (on the assumption that the width of the surface (b) is 1 cm.).

A. Surface (i) = 1 cm.^{2} Surface (b) = 8 cm.^{2} The proportion $i : b = 1 : 8$.

B. Surface (i_1) = 10×10 or 100 cm.^{2}
Surface (b_1) = $4 \times 10 + 4$ or 44 cm.^{2}
The proportion $i_1 : b_1 = 100 : 44$.

Therefore, in increasing the irradiated surface 100 times ($i : i_1 = 1 : 100$) the bordering surface is only increased six times ($b : b_1 = 8 : 44$). The bordering surface decreases in proportion as the irradiated surface increases. This results in progressive tolerance of the skin to the rays.

C. On irradiating the same surface of 100 cm.^{2} through a grill with quadrilateral openings 3×3 cm. in size (9 cm.^{2}), the lead strip between which is 0.5 cm. in width, an important bordering surface is created in the interior of the irradiated surface. The bordering surface is increased in this way at the same time with an increase in the tolerance to the roentgen rays.

condition there is an increase of radioactive potassium in the blood and of blood sugar, the oxidation of which is a source of mitogenetic irradiation (Gurwitsch). The cells which are about to become cancerous are subjected to particularly intense irradiation, for they are surrounded by photosensitizing substances, which results in acceleration of the process of division which may become anarchic and tumoral. Solar or roentgen cancers with cholesterin as a sensitizer are produced in this way (Roffo). The origin of the mitogenetic light may therefore be intrinsic or extrinsic. Tar cancer is only a cancer sensitized to tar, as tar, the benzanthracenes and the cholanthrenes are fluorescent substances with a spectrum defined by Schrotter. On the other hand, the irradiation of tarred surfaces accelerates the development of experimental cancer.

These ideas have a social application, as the industrial cities where the distillation of coal and benzene are carried on as a source of energy saturate their atmosphere with cancer-producing substances. Statistics are available which show an increase of the general mortality from cancer and from that of cancer of the lung particularly. Industrialization therefore runs parallel with a more intense cancerization. We need only call to mind the aniline factories (for tumors of the bladder) and the radium mines (for tumors of the lung) which by sensitizing certain tissues make them more likely to undergo cancerous changes.

The actinic theory of cancer therefore takes into account both the mechanism of radiotherapy and the origins of cancer.

CONCLUSIONS

We have irradiated tumors (Jensen's sarcoma) in young rats, giving them the lethal dose. The dose which was lethal for the animal's body was not so for the tumor cells, as they could be grafted on a fresh rat successfully if they were removed from the original rat in time: the later the grafting was carried out the less the vitality of the graft. On the other hand, preliminary irradiation of a fresh rat rendered it more or less refractory to the graft. As 25,000 r is the dose necessary to arrest proliferation of culture cells, this dose may be considered the direct dose. But it is obvious that 1,080 r (the lethal dose for the rat) cannot represent the dose for direct action, as it is only one-twentieth of the above dose. Its action is therefore indirect and does not decrease the vitality of the tumor immediately but only with the lapse of time. To increase the power of the roentgen rays on indirect action, we must therefore admit the existence of sensitizers which by fluorescence degrade the light and provoke a nuclear response in radiosensitive tissue and the absorption of an atom of oxygen. These premises constitute the basis for the actinic theory of cancer. It follows, therefore, that large surfaces are more radiosensitive than small ones and I have proposed the irradiation of large skin surfaces through the openings in a lead grill. This makes a checkerboard of small surfaces bordered by non-irradiated surfaces. Our experiments on rabbits have proved that the application of the lethal dose (1,500 r) has no effect if it is applied through a grill and that it must be doubled (3,000 r) to have a much less effect (the rabbit does not die until the end of three weeks instead of eight days). I have described three types of radiotherapy:

Direct action—which cannot be practiced on the living body.

Indirect action—irradiation by teleradiotherapy of large surfaces with small doses.

Mixed action—that is, the classical radiotherapy, a combination of direct and indirect.

Emphasis has been placed on the social importance of sensitizers: cancerization develops parallel with industrialization (hydrocarbon wastes of industry).

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Twenty-eighth Annual Meeting: 1945, canceled.

EDITORIAL

THE NEW ERA IN MEDICINE*

THIS war has brought a new era in American medicine. In the words of Watson-Jones: "War stimulates progress and particularly the progress of surgery. This has been true throughout all the ages. More suffering has been saved than was inflicted by all the wars of history and the conflict upon which we are now engaged has proved no exception." Stimulated by the war effort and backed by the funds and force of a government at war, the best efforts of our medical schools, hospitals and allied sciences have been focused on medical research to save lives and prevent disease. The increasing tempo of that research has placed medicine decades ahead of its position on September 1, 1939. In the field of military surgery, several theaters of the war report a mortality of less than 1 per cent of those wounded in battle. In every branch of medicine recent chemotherapy has established a new horizon. It has never before been possible for a patient with an advancing double pneumonia, an acute neisserian infection and a positive Wassermann reaction to leave the hospital in a fortnight cured of all three infections. In medicine as well as in surgery more lives will be saved in the near future than have been lost on the field of battle. Also stimulated by the demands of global war from steaming jungles, burning deserts, to arctic ice preventive medicine has reached the highest efficiency in history. Lieutenant General Somervell announced the report at the dedication of the Crile General Hospital: "Not a single American soldier has died of the bubonic plague, not a single American soldier has died of typhus, not a single American soldier has died of cholera or typhoid fever." This is a long way even from the experience of our Spanish-American War when more lives were lost from typhoid fever alone than from battle casualities.

These tremendous strides in medical science have been widely publicized. The need of good medical care and energetic health measures has reached a new level in the consciousness of the American public. It is receiving increasing consideration from industry, labor organizations, and from state and federal government. The Administration and the leaders of both political parties are committed to translate the tremendous progress of our wartime medicine and surgery into the health of the nation.

Under stimulus of the war the federal government has entered largely into the field of distribution of medical care. The millions of men and women in the armed services are now and will continue to be entitled to government medicine. The dependents of the Navy enlisted men are entitled to medical treatment and hospitalization. Under the Emergency Maternity and Infant Care Program hundreds of thousands of wives of service men are entitled to pre- and po t-natal care wit all the expense of delivery and hospitalization defrayed by the federal government. Under the Crippled Children's Act the state and the federal government share equally the expense of the treatment of these patients throughout the nation. In June, 1943, the federal government entered a new and tremendous medical program in the rehabilitation of the physically handicapped. It is estimated that not less than one and a half million persons are entitled to this medical care with a yearly increment of about one hundred thousand cases. The act of 1943 authorized the Federal Security Adminis-

* Address of the President of the American Roentgen Ray Society delivered at the Joint Meeting of the American Roentgen Ray Society and the Radiological Society of North America, Chicago, Ill., Sept. 24–29, 1944.

trator to pay one-half of the expense of corrective surgery and therapeutic treatment necessary to correct or modify a physical condition, which is static, and which constitutes a substantial handicap to employment. The disabled person must show need for such financial assistance, but there is no limit on the type of disability except that it be of such a nature that it can be corrected or modified within a reasonable length of time. Almost any medical, surgical or orthopedic condition can come under this classification, from gallstones or hyperthyroidism to an ununited fracture. Any underprivileged, physically handicapped person in the nation who can be improved or rendered more employable by medical or surgical treatment becomes a subject for this type of federal medicine. Tomorrow Dr. Hillboe will discuss with you the place of roentgenology in the public health program. He will lay before you the vast government enterprise of case finding in tuberculosis which promises to be universal. The nationwide venereal disease program sponsored by the Public Health Service provides diagnosis and treatment of any case and this product of the war years will also reach millions of patients. All of these projects if not primarily federal medicine are federally controlled on account of financing.

This vast program of federal medicine is at once an opportunity for and a challenge to radiology. The radiologist will welcome the opportunity to serve with his confrères in rehabilitation and in such public health service as proposed by Dr. Hilleboe. We will want to take our place along with the other physicians in this program just as we have done on selective service boards throughout the war and as our members are doing in the armed forces. We will consider this our duty and our privilege.

But there is a challenge in this program of federal medicine which is an important threat to the practice of radiology. Ever since the days of Caldwell and Leonard there has been a continuous struggle to establish and maintain radiology as the practice of medicine. Equal medical training and experience and equal responsibility have demanded and obtained equal place with other physicians in hospital practice. This relationship has been maintained in the Army and Navy hospitals in the war and its value to the patient and to the organization has been thoroughly demonstrated. But in these new civilian activities of the federal government, such as the Emergency Maternity and Infant Care Program, the Crippled Children's Act and the new rehabilitation program, the government demands that radiology be classed as a hospital service on the same plane as general nursing or the diet kitchen. The requirement is that all service rendered in the hospital including radiology, pathology and anesthesiology, be included and sold on a per diem basis. This edict places the approval of the federal government on those hospitals that have long tried to reduce radiology to a hospital service to be sold along with room and board. The threat arises that this program is crystallizing as a government policy and will cut the pattern for hospital radiology not only in the present civilian programs of the federal government but in all future extensions of federal medicine which may develop under extended social security. Once established, this program is irreversible.

A similar powerful threat to hospital radiology is developing with the widespread hospital insurance plans. Now covering about fifteen million subscribers, several plans include radiology as a hospital service and more are attempting it. While medical men as a whole, including radiologists, welcome prepaid hospitalization, the radiologist maintains that his services under that program are the practice of medicine and like those of his confrères cannot legitimately be sold as hospital care.

The problems of the practice of radiology in the new era of medicine are no longer the problems of the individual. The radiologist is no longer facing his problems of practice with his hospital superintendent and his local board of directors. He is now confronting tremendous forces of federal and state

government and financially powerful hospital associations, many of which question his position and threaten his practice.

If the practice of radiology is to grow and survive as a medical specialty it will require the full force of our united efforts in dealing with these national problems. This does not mean that we must form a labor organization or selfish pressure groups, but it does mean a highly integrated union between all the radiologists in America in matters dealing with public policy. There must be no hesitation and no division in facing these problems as they arise. We must always be ready for prompt, forceful, united, official conferences with government agencies, with the American Medical Association, or with the American Hospital Association. This will require the closest contact between the executive officers of these two scientific societies and those of the American College of Radiology and of the Section of Radiology of the American Medical Association. The committees of all four organizations that have to deal with public relations should be either identical or should be largely overlapping so that every such committee may speak officially for all of radiology including these four organizations. This Joint Meeting and the two Congresses that have preceded it, in 1933 and in 1937, fully demonstrate that the entire profession of radiology in America can work together cordially and efficiently in their scientific problems. There is every reason to believe that these organizations can work equally well together as a forceful and compact unit in all their public policy relations.

The goal of radiology will always be, as it was in the pioneer days, to become an increasingly vital and integral part of the practice of medicine. The present trend in federal medicine, social security and prepaid hospital plans make the struggle to that end more important than at any time in the past forty-nine years. If we are to promote and preserve radiology as a medical specialty, we must continue that struggle with all the force and energy at our command. Our success will depend largely on the wisdom and foresight of our public policy and upon how firmly we are united in carrying out that policy. But above all, the future of radiology in the new era will, as it always has, depend upon our determination to make ourselves better physicians and to make our work increasingly necessary to the practice of better medicine.

Lyell C. Kinney

SOCIETY PROCEEDINGS, CORRESPONDENCE AND NEWS ITEMS

Items for this section solicited promptly after the events to which they refer.

MEETINGS OF ROENTGEN SOCIETIES*

United States of America

American Roentgen Ray Society
Secretary, Dr. H. Dabney Kerr, University Hospital, Iowa City, Iowa. Annual meeting: 1945, canceled.

American College of Radiology
Secretary, Mac F. Cahal, 540 N. Michigan Ave., Chicago.

Section on Radiology, American Medical Association
Secretary, Dr. U. V. Portmann, Cleveland Clinic, Cleveland, Ohio. Annual meeting: 1945, canceled.

Arkansas Radiological Society
Secretary, Dr. J. S. Wilson, Mack Wilson Hospital, Monticello, Ark. Meets every three months and also at time and place of State Medical Association.

Radiological Society of North America
Secretary, Dr. D. S. Childs, 607 Medical Arts Bldg., Syracuse, N. Y. Annual meeting: 1945, to be announced.

Radiological Section, Baltimore Medical Society
Secretary, Dr. Walter L. Kilby, Baltimore. Meets third Tuesday each month, September to May.

Section on Radiology, California Medical Association
Secretary, Dr. Earl R. Miller, University of California Hospital, San Francisco, Calif.

Radiological Section, Connecticut Medical Society
Secretary, Dr. Max Climan, 242 Trumbull St., Hartford, Conn. Meets bi-monthly on second Thursday, at place selected by Secretary. Annual meeting in May.

Section on Radiology, Illinois State Medical Society
Secretary, Dr. H. W. Ackemann, 321 W. State St., Rockford, Ill.

Radiological Section, Los Angeles County Medical Association
Secretary, Dr. Roy W. Johnson, 1407 S. Hope St., Los Angeles, Calif. Meets on second Wednesday of each month at the County Society Building.

Radiological Section, Southern Medical Association
Secretary, Dr. Roy G. Giles, Temple, Texas.

Brooklyn Roentgen Ray Society
Secretary, Dr. Leo Harrington, 880 Ocean Ave., Brooklyn, N.Y. Meets monthly on fourth Tuesday, October to April.

Buffalo Radiological Society
Secretary, Dr. Joseph S. Gian-Francheschi, 610 Niagara St., Buffalo, N. Y. Meets second Monday of each month except during summer months.

Chicago Roentgen Society
Secretary, Dr. F. H. Squire, 1754 W. Congress St., Chicago 12, Ill. Meets second Thursday of each month October to April inclusive at the Palmer House.

Cincinnati Radiological Society
Secretary, Dr. Samuel Brown, 707 Race St., Cincinnati, Ohio. Meets third Tuesday of each month, October to May, inclusive.

Cleveland Radiological Society
Secretary, Dr. D. D. Brannan, 11311 Shaker Blvd., Cleveland 4, Ohio. Meets at 6:30 P.M. at Allerton Hotel on fourth Monday each month, October to April, inclusive.

Dallas-Fort Worth Roentgen Study Club
Secretary, Dr. X. R. Hyde, Medical Arts Bldg., Fort Worth, Texas. Meetings held in Dallas on odd months and in Fort Worth on even months, on third Monday, at 7:30 P.M.

Denver Radiological Club
Secretary, Dr. A. Page Jackson, Jr., 1612 Tremont Place, Denver, Colo. Meets third Friday of each month at Denver Athletic Club.

Detroit Roentgen Ray and Radium Society
Secretary, Dr. E. R. Witwer, Harper Hospital. Meets monthly on first Thursday from October to May, at Wayne County Medical Society Building.

Florida Radiological Society
Acting Secretary, Dr. Walter A. Weed, 204 Exchange Bldg., Orlando, Fla. Meetings in May and November.

Georgia Radiological Society
Secretary, Dr. James J. Clark, 478 Peachtree St., Atlanta, Ga. Meets in November and at annual meeting of Medical Association of Georgia in the spring.

Radiological Society of Kansas City
Secretary, Dr. Arthur B. Smith, 800 Argyle Bldg., Kansas City, Mo. Meets third Thursday of each month.

Illinois Radiological Society
Secretary, Dr. Wm. DeHollander, St. John's Hospital, Springfield, Ill. Meets three times a year.

Indiana Roentgen Society
Secretary, Dr. H. C. Ochsner, Methodist Hospital, Indianapolis. Meets annually second Sunday in May.

Iowa X-Ray Club
Secretary, Dr. Arthur W. Erskine, 326 Higley Bldg., Cedar Rapids, Iowa. Luncheon and business meeting during annual session of Iowa State Medical Society. Special meetings by announcement.

Kentucky Radiological Society
Secretary, Dr. W. C. Martin, 321 W. Broadway, Louisville. Meets annually in Louisville on first Saturday in Apr.

Long Island Radiological Society
Secretary, Dr. Marcus Wiener, 1430-48th St., Brooklyn, N. Y. Meets Kings County Med. Soc. Bldg. monthly on fourth Thursday, October to May, 8:30 P.M.

Louisiana Radiological Society
Secretary, Dr. J. R. Anderson, 1130 Louisiana Ave., Shreveport. Meets annually during Louisiana State Medical Society Meeting.

Michigan Association of Roentgenologists
Secretary, Dr. E. M. Shebesta, 1429 David Whitney Bldg., Detroit. Three meetings a year, Fall, Winter, Spring.

Milwaukee Roentgen Ray Society
Secretary, Dr. C. A. H. Fortier, 231 W. Wisconsin Ave., Milwaukee, Wis. Meets monthly on second Monday at University Club.

Minnesota Radiological Society
Secretary, Dr. Annette T. Stenstrom, 1218 Medical Arts Bldg., Minneapolis, Minn. One meeting a year at time of Minnesota State Medical Association.

Nebraska Radiological Society
Secretary, Dr. D. A. Dowell, Medical Arts Bldg., Omaha, Nebr. Meets third Wednesday of each month, at 6 P.M. at either Omaha or Lincoln.

New England Roentgen Ray Society
Secretary, Dr. George Levene, Massachusetts Memorial Hospitals, Boston, Mass. Meets monthly on third Friday, Boston Medical Library.

New Hampshire Roentgen Ray Society
Secretary, Dr. Richard C. Batt, Berlin, N. H. Four meetings a year.

Radiological Society of New Jersey
Secretary, Dr. H. R. Brindle, 501 Grand Ave., Asbury Pk. Meets annually at time and place of State Medical Society. Mid-year meetings at place chosen by president.

New York Roentgen Society
Secretary, Dr. Ramsay Spillman, 115 East 61st St., New York City. Meets monthly on third Monday, New York Academy of Medicine, at 8:30 P.M.

North Carolina Roentgen Ray Society
Secretary, Dr. Major Fleming, Rocky Mount, N. C. An-

* Secretaries of Societies not here listed are requested to send the necessary information to the Editor.

nual meeting at time and place of State Medical Society. Mid-year scientific meeting at place designated.

North Dakota Radiological Society
Secretary, Dr. L. A. Nash, St. John's Hospital, Fargo. Meetings held by announcement.

Central New York Roentgen Ray Society
Secretary, Dr. C. F. Potter, 820 S. Crouse Ave., Syracuse. Three meetings a year. January, May, November.

Ohio Radiological Society
Secretary, Dr. Henry Snow, 1061 Reibold Bldg., Dayton, Ohio. Meets during annual meeting of Ohio State Medical Association.

Pacific Roentgen Society
Secretary, Dr. L. H. Garland, 450 Sutter St., San Francisco, Calif. Meets annually, during meeting of California Medical Association.

Pennsylvania Radiological Society
Secretary, Dr. L. E. Wurster, 416 Pine St., Williamsport. Next annual meeting, Hotel William Penn, Pittsburgh, May 5–6, 1945.

Philadelphia Roentgen Ray Society
Secretary, Dr. R. I. Barden, University Hospital, Meetings first Thursday of each month from October to May inclusive at 8:15 P.M., in Thompson Hall, College of Physicians, 19 S. 22d St.

Pittsburgh Roentgen Society
Secretary, Dr. L. M. J. Freedman, 4800 Friendship Ave. Meets second Wednesday each month, 4:30 P.M., October to June, Pittsburgh Academy of Medicine.

Rochester Roentgen Ray Society, Rochester, N. Y.
Secretary, Dr. Murray P. George, Strong Memorial Hospital. Meets monthly on third Monday from October to May, inclusive, 8 P.M. at Strong Memorial Hospital.

Rocky Mountain Radiological Society
Secretary Dr. A.M. Popma, 220 N. First St., Boise, Idaho.

St. Louis Society of Radiologists
Secretary, Dr. Edwin C. Ernst, Beaumont Medical Building, St. Louis, Mo. Meets fourth Wednesday of each month, except June, July, August, and September, at a place designated by the president.

San Diego Roentgen Society
Secretary, Dr. Henry L. Jaffe, Naval Hospital, Balboa Park, San Diego, Calif. Meets monthly on first Wednesday at dinner.

San Francisco Radiological Society
Secretary, Dr. Carlton L. Ould, University of California Hospital, San Francisco 22. Meets monthly on the third Thursday at 7:45 P.M., first six months of the year at Lane Hall, Stanford University Hospital, and second six months at Toland Hall, University of California Hospital.

Shreveport Radiological Club
Secretary, Dr. R. W. Cooper, Charity Hospital, Shreveport, La. Meets monthly on third Wednesday, at 7:30 P.M., September to May inclusive.

South Carolina X-Ray Society
Secretary, Dr. T. A. Pitts, Baptist Hospital, Columbia, S. C. Meets in Charleston on first Thursday in November, also at the time and place of South Carolina State Medical Association.

Tennessee Radiological Society
Secretary, Dr. J. M. Frère, 707 Walnut St., Chattanooga, Tenn. Meets annually at the time and place of the Tennessee State Medical Association.

Texas Radiological Society
Secretary, Dr. Asa E. Seeds, Baylor Hospital, Dallas, Texas. Next annual meeting, Temple, Texas, Jan. 17, 1945.

University of Michigan Department of Roentgenology Staff Meeting
Meets each Monday evening from September to June, at 7 P.M. at University Hospital.

University of Wisconsin Radiological Conference
Secretary, Dr. E. A. Pohle, 1300 University Ave., Madison, Wis. Meets every Thursday from 4:00–5:00 P.M., Room 301, Service Memorial Institute.

Virginia Radiological Society
Secretary, Dr. E. L. Flanagan, 116 E. Franklin St., Richmond, Va. Meets annually in October.

Washington State Radiological Society
Secretary, Dr. Thomas Carlile, 1115 Terry St., Seattle. Meets fourth Monday each month, October through May, College Club, Seattle.

X-ray Study Club of San Francisco
Secretary, Dr. J. M. Robinson, University of California Hospital. Meets monthly, third Thursday evening.

Cuba

Sociedad de Radiología y Fisioterapia de Cuba
President, Dr. J. Manuel Viamonte, Hospital Mercedes, Habana, Cuba. Meets monthly in Habana.

British Empire

British Institute of Radiology Incorporated with the Röntgen Society
Medical Members' meeting held monthly on third Friday at 2:30 P.M. and Ordinary Meeting at same time on following Saturday, October to May, 32 Welbeck St., London, W.1.

Section of Radiology of the Royal Society of Medicine (Confined to Medical Members)
Meets on the third Friday of each month at 4:45 P.M. at the Royal Society of Medicine 1, Wimpole St., London, W. 1.

Faculty of Radiologists
Secretary, Dr. M. H. Jupe, 32 Welbeck St., London, W. 1 England.

Section of Radiology and Medical Electricity, Australasian Medical Congress
Secretary, Dr H. M. Cutler, 139 Macquarie St., Sydney, New South Wales.

Radiological Section of the Victorian Branch of the British Medical Association
Secretary, Dr. Keith Hallam, St. George's Hospital, K.E.W., Melbourne, E. 4, Victoria, Australia. Meets monthly from March to November inclusive.

Canadian Association of Radiologists
Secretary, Dr. J. W. McKay, 1620 Cedar Ave., Montreal, P. Q.

Section of Radiology, Canadian Medical Association
Secretary, Dr. C. M. Jones, Inglis St., Ext. Halifax, N. S.

Radiological Section, New Zealand British Medical Association
Secretary, Dr. Colin Anderson, Invercargill, New Zealand. Meets annually.

South America

Sociedad Argentina de Radiologia
Secretary, Dr. Guido Gotta, Buenos Aires, Argentina. Meetings are held monthly.

Sociedad Peruana de Radiologia
Secretary, Dr. Victor Giannoni, Apartado, 2306, Lima, Peru. Meetings held monthly except during January, February and March, at the Asociación Médica Peruana "Daniel A. Carrión, Villalta, 218, Lima.

Continental Europe

Sociedad Espanola de Radiologia y Electrologia
Secretary, Dr. J. Martin-Crespo, Fuencarral, 7. Madrid, Spain. Meets monthly in Madrid.

Société Suisse de Radiologie (Schweizerische Röntgen-Gesellschaft)
Secretary for French language, Dr. A. Grosjean La Chaux de Fonds.
Secretary for German language, Dr. Scheurer, Molzgasse Biel. Meets annually in different cities.

Societatea Romana de Radiologie si Electrologie
Secretary, Dr. Oscar Meller, Str. Banul Mărăcine, 30, S. I., Bucuresti, Roumania. Meets second Monday in every month with the exception of July and August.

All-Russian Roentgen Ray Association, Leningrad: USSR in the State Institute of Roentgenology and Radiology, 6 Roentgen St.
Secretaries, Drs. S. A. Reinberg and S. G. Simonson. Meets annually.

Leningrad Roentgen Ray Society
Secretaries, Drs. S. G. Simonson and G. A. Gusterin. Meets monthly, first Monday at 8 o'clock, State Institute of Roentgenology and Radiology, Leningrad.

Moscow Roentgen Ray Society
Secretaries, Drs. L. L. Holst, A. W. Ssamygin and S. T. Konobejevsky. Meets monthly, first Monday, 8 P.M.

Scandinavian Roentgen Societies
The Scandinavian roentgen societies have formed a joint association called the Northern Association for Medical Radiology, meeting every second year in the different countries belonging to the Association.

AMERICAN COLLEGE OF RADIOLOGY

REPORT OF THE EXECUTIVE SECRETARY

In his excellent book comparing the theories of Oswald Spengler and Raymond Pearl, "Today and Destiny," Edwin F. Dakin expresses a truism that is of particular significance for doctors in these dynamic times: "Any concept—economic, political, or cultural—which leaves its possessor wholly unprepared for tomorrow is of doubtful validity. Conversely, men who are not surprised when the future comes, lie very close to the truth."

President Lowell S. Goin was pleading for a true concept of the future when, in a recent letter to Members and Fellows of the College, he warned of impending social changes that would almost certainly result in new methods of distribution for medical services. He urged radiologists to actively encourage voluntary prepayment plans for medical care, sponsored by medical societies, as the soundest and most desirable method among the many that have been proposed. At the same time, he warned that some form of socialized medicine, embodying compulsory health insurance, is not an inconceivable eventuality.

Doctor Goin's concern would seem to be justified by what most observers have recognized as an increasing pressure of public opinion. The attitude of the public was succinctly expressed by *Fortune* in its December issue: "The state of medicine in the United States is a social problem because the country's conscience has made it so . . . people who cannot find or pay for proper medical care are resentful."

I have been sharply criticized in some quarters for a statement made in my annual report to the Board of Chancellors two years ago in which I referred to the powerful social forces at work throughout the world and their manifestation in agitation for socialized medicine in this country. I remarked that there was a growing conviction among medical men that a head-on opposition to this unmistakable trend would be as unwise as it would be futile. Subsequent events have proved, I believe, that the demands for improvements in the distribution of medical services must be met, either by voluntary plans for prepayment or, if not, then by compulsory health insurance. It seems unnecessary to recite the extensive evidence that this is so. A half dozen public opinion surveys have revealed a definite public demand for insurance against medical costs.

Brigadier General Fred W. Rankin, in his presidential address before the American Medical Association House of Delegates last year, called upon the medical profession to recognize the gathering momentum of trends that are "directed toward some form of national health service as an integral function of the state." He made a plea that they be regarded not in the light of apostasy, but rather in the light of realism.

Dr. Allan Gregg, whose words carry considerable weight in the medical world, has uttered a similar warning. "The danger for medicine in America lies in failure to acknowledge and to study the sociologic aspects of medicine—the social matrix. We are loath to see that research and teaching, as well as the practice of medicine, will change when change comes in the prevalent interpretations of the role of government and the structure of our society," he says.

It would appear, therefore, that if we are not to be unprepared for tomorrow, we should give consideration in our deliberations to the likely effects of all the various proposals for changes in the economics of medicine. It is a poor general who fails to consider the probable results of every possible contingency that may alter the existing situation.

In our efforts to peer into the future of medical practice in the United States I think we should keep one very important point clearly in mind. It is this: Every system of compulsory health insurance in all the countries of the world has been built upon existing agencies for the distribution

of medical care. On the basis of history, therefore, we can assume that, if a system of compulsory health insurance is adopted by Federal or State governments in this country, existing plans for the application of the insurance principle to payment for medical care would be utilized by the state. The obvious corollary is that medical practitioners would carry on under the state plan much as they did under the voluntary plans which preceded it. This has been almost the universal experience in European systems.

Writing on the "Origins of Health Insurance," in their excellent book on this subject, Simons and Sinai show that compulsory health insurance is built out of three existing institutions: insurance or prepayment plans, the state, and the medical professions. "The relations, reactions, and relative strength of these determine much of the character and results of the operation of existing insurance systems," they say. Their study of compulsory health insurance throughout the world leads them to conclude that pre-existent voluntary prepayment plans have dominated the state systems which followed.

Douglas and Jean Orr, in their book on the British experience with health insurance, point out that the form which the national health system of England finally took was determined by the "friendly societies" which had existed for many years as voluntary plans for prepayment to meet the costs of sickness.

Sir William Beveridge, in his epoch-making report on social insurance in England, observes the part which the voluntary plans have played in setting the pattern of the government system. He contemplates, though with frank displeasure, that they will continue to be utilized as distributing agencies in the expanded system which will undoubtedly be adopted in Great Britain.

He implies, incidentally, as have others before him, that voluntary sickness insurance promotes, rather than deters, the adoption of compulsory systems. In 1909 David Lloyd George pointed to the "friendly societies," which were comparable to our present prepayment plans, as proof of the feasibility and desirability of compulsory sickness insurance. The National Health Insurance Act came three years later. It is significant, perhaps, that efforts to enact compulsory insurance laws in our own country are today most concentrated in the two states with the oldest and largest voluntary medical service plans, California and Michigan.

We all hope that voluntary prepayment plans, sponsored either by medical societies or commercial insurance carriers, will meet the palpable demand of the public for relief from the unpredictable financial burdens of illness. If they do not, the lessons of history teach us that organized medicine has yet another compelling reason for extending these plans as rapidly and as widely as possible. Once firmly established, they would set the pattern and determine the methods to be followed in the event a compulsory system is adopted.

This is a matter of the very greatest importance for the doctors of America. It is surely unnecessary to remark, for instance, that the future of radiology will largely be determined by its status in voluntary prepayment plans, whether or not these plans are later superseded by a compulsory system. Precedents are being established in the experiments by medical societies which demand from the leaders of thought in American medicine the highest order of statesmanship and sound judgment.

Now, in the light of these considerations, the group hospitalization movement, concerning which organized medicine has been exceedingly circumspect, acquires a new importance that tends to justify medicine's diffidence. Are the Blue Cross plans to duplicate the history of England's friendly societies? Two facts lend credence to an assumption that this is altogether possible.

First, a determined effort is being made by directors of Blue Cross plans to extend their benefits to include complete surgical

or medical care. Second, Blue Cross plans would almost certainly be preserved and integrated in a compulsory sickness insurance plan.

The first of these statements will be promptly denied by Blue Cross leaders. But the facts speak for themselves. In Delaware, the Blue Cross plan has already been expanded to include cash benefits for surgical care. It is administered by a Board of Trustees on which there are two hospital representatives for every doctor. Also in West Virginia and North Carolina hospital service plans have assumed full control of medical care plans.

The American Hospital Association, at its recent annual meeting, considered recommendations from several speakers for "extending prepaid hospital plans to cover outpatient care." At the same meeting the Hospital Service Plan Commission approved a proposed model enabling act for comprehensive health service plans which would require, among other things, that any plan incorporated under the act be controlled by a board composed of one-third hospital trustees, one-third doctors, and one-third lay representatives of the public. In the course of the discussions, Mr. Louis H. Pink, president of Associated Hospital Service of New York City, urged expansion of Blue Cross to include the costs of medical care without delay.

In Philadelphia, where the medical society several years ago fought a bitter and unsuccessful battle to exclude radiology and pathology from the hospital service plan, a proposal has very recently been submitted to add complete medical care to Blue Cross benefits. The proponents candidly recommend repeal of the present Pennsylvania enabling act, which requires that a majority of the directors of medical service corporations be doctors of medicine.

Now I desire that I not be misunderstood. Cooperation between hospital service plans and medical or surgical service plans is essential. It is rather generally agreed among hospital leaders that Blue Cross enrollment has about reached its maximum unless contracts for hospital service can be coupled with insurance against medical costs. There is no doubt that the United States Public Health Service will emphasize this fact in the report of a study it is currently making of the movement. Furthermore, it is both logical and economical to delegate responsibility for sale and routine administration of the medical service plan to existing Blue Cross plans which have several years of experience and have acquired trained personnel.

But, medical societies which turn over complete control of prepaid medical care to Blue Cross plans that are controlled by hospitals are traveling a dangerous road. They are violating one of the basic principles of organized medicine if they fail to establish a separate corporation to control the medical plan, with a board of directors of which at least a majority are doctors.

Ten years ago the American Medical Association laid down the postulate that: "All features of medical service in any method of medical practice should be under the control of the medical profession. No other body or individual is legally or educationally equipped to exercise such control." This principle has lost none of its validity.

If anyone is inclined to minimize the importance of this principle, he has but to follow the course of the controversy that has persisted between hospital service plans and the organized medical profession over the inclusion of certain medical services as a part of hospital care. For ten long years county, state, and national medical organizations have insistently demanded that radiology and pathology be excluded from Blue Cross benefits. Everyone knows that the reaction of hospitals to these unequivocal demands has been one of polite indifference. What makes anyone think they would follow the dictates of the medical profession concerning other branches of medicine, once they were in control of medical service plans?

Constantly during recent years the American College of Radiology has warned that medicine would sacrifice a basic prin-

ciple if it yielded to the adamant demand of hospitals that they be permitted to include radiology and pathology in Blue Cross benefits as a part of hospital care. Too often our admonition that this would open the door to further encroachments by which hospitals would assume added prerogatives in the delivery of medical services has fallen on unheeding ears. Now, as one medical editor has sardonically remarked, "The beans are on the carpet, spread out for all to see."

The second fact stated above, that Blue Cross plans would be integrated in a system of compulsory insurance, is likewise more than a mere assumption. Witness the curious tergiversation that has taken place in Rhode Island. Not long ago the governor of Rhode Island proposed a law for compulsory hospitalization insurance in his state. Promptly Blue Cross executives all over the country assailed the proposal as "un-American" and "regimentation." But, when the governor publicly announced that he contemplated the use of Blue Cross as an agency under the system, opposition quietly died.

The Wagner-Murray-Dingell bill, as you know, authorizes the Surgeon General to "negotiate agreements . . . with private agencies or institutions . . . to utilize their services and facilities . . . ." In response to a question from hospital spokesmen, Surgeon General Parran has already expressed the view that this would include Blue Cross plans.

I would point out that this provision in the bill would also permit medical service plans operated by medical societies to enter into contracts for rendering services to beneficiaries. Significant also is the provision in the Wagner bill which permits the practitioners in each area to elect the method by which payment shall be made for services.

Does this not offer sufficient reason for medical societies to set up their own plans for prepaid medical care? Surely the leaders of medicine can see the wisdom of establishing proper precedents now.

Unfortunately for radiologists, all the current problems confronting the private practice of medicine are egregiously manifest in the case of radiology. The threat of compulsory health insurance offers no exception. The future progress and advancement of the science of radiology may very well be determined by the status this specialty is accorded in voluntary plans for prepayment. Thus, the long unhappy fight of the American College of Radiology against the inclusion of medical services as a part of hospital care in group hospitalization assumes added significance.

It is encouraging to note that considerable progress has been made in solving this controversy. In Washington and Iowa, for instance, Blue Cross has agreed to separate radiology from hospital care and to pay cash benefits to the physician for x-ray services. The next step is to transfer these medical benefits from the hospital service plan to the medical service plan, where they belong. This has already been agreed to in New York, where, incidentally, the battle between radiologists and the hospital service plan has been hottest. Last year the Hospital Association of New York State approved a resolution providing that, "In those counties or areas where a Blue Shield Medical Care Plan exists, all prepaid medical and surgical care provided for under any prepaid plan and given through the hospitals or outside of the hospitals should be covered under the Blue Shield Medical Care Plan." The hospital association agreed that when medical service plans were established in areas where they do not now exist, the Blue Cross plan in the community would drop radiology, pathology, anesthesiology, and physiotherapy from its benefits and allow these services to be covered like other medical specialties in the medical service plan. We should offer our commendations to the New York Hospital Association for this splendid step toward solution of a controversy that has unfortunately caused ill feeling on all sides and has undoubtedly retarded the growth of the Blue Cross movement.

Now, then, we have added incentive to continue our endeavors to place radiology on an equal footing with other medical specialties in all plans for prepaid health service. In voluntary plans, the services of a radiologist should be provided like other consultant's services among medical benefits. They should never be included in the per diem paid to hospitals for hospital care. Furthermore, with due respect for the many excellent features of the Blue Cross movement I think we have every reason to raise our voice in opposition to those who would allow the hospital service plans to adopt the role of England's friendly societies by assuming control of medical care plans. There is a place for both, operating in close cooperation but each autonomous in its own field.

Although some of the proposals for compulsory health insurance submitted to Congress in recent years have included radiology among the services to be furnished by hospitals for a specified der diem, the Wagner-Murray-Dingell bill provides for separate payment to radiologists. It would be unfortunate if Blue Cross were to establish a different precedent. I believe we are justified in doubting that Blue Cross plans would separate radiology from hospital care if they were permitted to extend their benefits to cover medical or surgical services.

I have attempted here to present a point of view, which I think carries profound consideration for American medicine, and especially for radiology. I have not said that voluntary plans of sickness insurance will be superseded by a compulsory system. I honestly do not believe they will be. But, as my friend A. M. Simons has wisely said, social experiments invariably establish patterns of precedent that are seldom completely reversed. In these dynamic times we have extra reason to be vigilant and to exercise sound judgment in our decisions.

Fortunately for the radiologists of America, an instrument for maintaining vigilance and directing policies on the basis of sound interpretation exists through the American College of Radiology. It provides what former President W. Edward Chamberlain has referred to as "fire-fighting machinery." Even if the fires cannot always be extinguished, the program of the College keeps them under control and helps to guide the course of future events in a direction least harmful to accepted principles of good radiologic practice.

Medical Economics, in a recent article, referred with approval to the aggressive program of the College and observed that it was leading the spearhead of medicine's fight against the tendency for third-party agencies to assume the rôle of distributing agencies for medical services. Said *Medical Economics:* "While the other clinical specialists have a large stake in any such dispute, the radiologists are taking the lead through their vigorous organization, the American College of Radiology."

The reports of the various Commissions and Committees of the Board of Chancellors to be presented at this meeting offer good evidence of the fact that the College is alert, informed, and active, and that it has a positive program for the preservation of essential principles. This program, of course, is not confined solely to socioeconomics. The broad scope of the College program in education, hospital standards, and other activities of the organization are directed toward a single objective: the advancement of the science of radiology and the promotion of its contributions to human welfare.

I am constrained to say again, as I have before, that the Members and Fellows of the American College of Radiology should be grateful to their appointed leaders who direct the affairs of the College for the unselfish effort these individuals are devoting in a cause which they approach with the deepest sincerity. For myself, I am grateful for the continued encouragement and the warm cooperation I have enjoyed from these officers and committee members. I would be ungrateful if I failed to say that I appreciate the confidence you have expressed in permitting me to return to a work for which I too have sincere devotion.

MAC F. CAHAL
Executive Secretary

CANCER TEACHING DAY

A Cancer Teaching Day will be held at the Arnot-Ogden Memorial Hospital, Elmira, New York, on Wednesday, May 23, 1945, under the auspices of the Medical Society of the County of Chemung and other sponsoring societies. The meeting will be called to order at 4.30 P.M., and the following papers will be presented:

Hormone Therapy and the Prevention of Gynecologic Malignancies. Clyde L. Randall, M.D., Buffalo, N. Y.

Carcinoma of the Genitourinary Tract. Archie L. Dean, M.D., New York, N. Y.

The evening meeting will be addressed by Cushman D. Haagensen, M.D., New York, N. Y., on the subject of "Diagnosis and Treatment of Breast Cancer."

CANCER SYMPOSIUM FOR PHYSICIANS

On April 13, 1945, at the Garden City Hotel, Garden City, New York, was held an All-Day Cancer Symposium for Physicians arranged by the Nassau County Cancer Committee with a number of sponsoring organizations. The following program was presented:

Five Years of Cancer Reporting in Nassau. Earle G. Brown, M.D., Mineola, N. Y.

The Diagnostic Problems of Early Cancer. Lloyd F. Craver, M.D., New York, N. Y.

Cancer of the Genitourinary Tract. Clyde L. Deming, M.D., New Haven, Conn.

Gynecological Cancer. James A. Corscaden, M.D., New York, N. Y.

Physical Basis for the Use of X-Rays and Radium in the Treatment of Cancer. Edith H. Quimby, Sc.D., New York, N. Y.

Cancer of the Breast. Lieut. Commander Charles F. Geschickter, Bethesda, Md.

Gastrointestinal Cancer. George T. Pack, M.D., New York, N. Y.

RADIOLOGICAL SECTION OF THE LOS ANGELES COUNTY MEDICAL ASSOCIATION

At a meeting of the Radiological Section of the Los Angeles County Medical Association the following officers were elected for the ensuing year: *President*, Dr. Donald R. Laing; *Vice-President*, Dr. Herbert A. Judson; *Secretary*, Dr. Roy W. Johnson; *Treasurer*, Dr. Henry Snure.

NEW HAMPSHIRE ROENTGEN RAY SOCIETY

At a recent meeting, the radiologists of New Hampshire organized the New Hampshire Roentgen Ray Society and elected the following officers: *President*, Dr. Fred S. Eveleth, Concord, N. H.; *Secretary-Treasurer*, Dr. Richard C. Batt, Berlin, N. H.

BOOK REVIEWS

Books sent for review are acknowledged under: Books Received. This must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interest of our readers as space permits.

Medical Radiographic Technic. Prepared by The Technical Service Department of General Electric X-Ray Corporation under the editorial supervision of Glenn W. Files, Director. Cloth. Price, $6.00. Pp. 365, with 381 illustrations. Springfield, Illinois: Charles C Thomas, 1943.

This book is described as one written by technicians for technicians. However, roentgenologists should not assume that it is therefore of no interest to them, for the better roentgenologists have served an apprenticeship in technique, acquiring by actual experience a knowledge of the problems of their technical assistants and an ability to criticize helpfully, as well as in deprecation of unsatisfactory work. Only thus, can the most satisfactory roentgenologic practice be conducted.

Files and his collaborators have produced a book which is fundamentally practical. Enough of the theory of physics and chemistry is included to provide a basic knowledge of the design, construction and use of roentgen apparatus, sufficient knowledge to enable the technician to pass the examination required for a certificate of registration.

Positioning is adequately covered by the excellent illustrations which make use of the device of photographing a mirror placed alongside of the subject in order to give an additional view and show the centering more exactly. Angles of tilt and shift of the tube are superimposed on the prints. Not all possible variations of positioning could be included in one volume, but those chosen are practical and sufficiently inclusive for most examinations.

The details of procedure as to kilovoltage, variation with part thickness, milliampere-seconds, and other helpful suggestions, are applicable to various machines to a remarkable degree. Dental technique is illustrated with the more common and, at the same time, more difficult technique, using the horizontal table rather than the special tube and dental chair. This seems a wise choice on the part of the authors.

While planigraphy and photography of the fluorescent screen image may not be used by the average technician, their inclusion in this book is an indication of its scope and completeness.

Medical Radiographic Technic is in its second printing and is no longer an untried project. It has been the privilege of this reviewer to employ it in training of several inexperienced technicians, and the results have exceeded expectations. Since roentgenographic procedures vary with the type of equipment, the needs of the particular case and the personal preferences of the individual, some will find details to criticize. However, a fair and impartial appraisal of the subject matter and its presentation will place this book high on the list of practical books on roentgenographic technique.

E. W. Hall

Physiology in Aviation. By Chalmers L. Gemmill, B.S., M.D., Commander, MC, USNR; Associate Professor in Physiology, Johns Hopkins University, School of Medicine, Baltimore, Maryland; Instructor in Physiology, School of Aviation Medicine, Naval Air Station, Pensacola, Florida. Cloth. Price, $2.00. Pp. 129, with 18 illustrations. Springfield, Illinois: Charles C Thomas, 1943.

This handbook, prepared by a former Associate Professor of Physiology in the Johns Hopkins University School of Medicine, and now a Commander in the Navy and Instructor in Physiology, School of Medicine, Naval Air Station, Pensacola, Florida, fills a practical need. It is a concisely presented, authoritative, easily read and understood presentation of the essential facts dealing with the reaction of the body to changes incident to flying at different levels of the atmosphere. Although it was prepared primarily for students of aviation, it should be of interest also to many others, for these days all intelligent persons should have some knowledge of the problems and their solution in this rapidly growing and important field.

Such a book as this may serve the useful purpose of introducing some of the parents of the country to an understanding of environmental changes to which their sons are subjected daily in the course of their duties in the present war. Furthermore, it should evoke their gratitude to

learn of the safeguards that are established by the armed forces in an attempt to overcome the more important hazards of flying.

Several problems incident to the introduction of the modern aeroplane merit special attention. Among the more important are anoxia, the effects of acceleration, and aero-embolism. Anoxia and aero-embolism are not new problems because the effects of the former are familiar to every physician, and the latter has been known to occur in deep sea divers and caisson workers for years. An interest in both conditions, however, has been greatly stimulated by the rapid expansion of aviation.

The problem of acceleration is one of peculiar interest as it applies only to persons subjected to the changes occurring in rapid flight. Apparently it is not the velocity *per se* which affects the man but rapid changes in speed, either through an increase or decrease, which exerts its influence. Some of these effects are described as follows: At two gravitational units, designated as "g," (each unit being the force which will pull a body toward the earth with an acceleration of 32 feet per minute) there is an increase in the sensation of pressing on the surface upon which the aviator is seated; at 4 g, the legs and arms become heavy and can only be moved with effort, at 5 g the extremities cannot be moved at all, the blood is felt to leave the face, respiration becomes difficult, there may be loss of vision, and later, loss of consciousness. The objective symptoms are attributable to the fall in blood pressure which results from an accumulation of blood in the abdominal vessels. This causes a decrease in the return of blood to the heart, with an associated fall in the cardiac output. "Black out" occurs before loss of consciousness because when the blood pressure drops sufficiently, the intraocular pressure will cause the retinal vessels to collapse while the blood will still flow through the retinal vessels. If the blood pressure falls to the vicinity of the intraventricular pressure, then consciousness is lost.

The above brief discussion is given to provide a sample of one of the many interesting phases of the subject which are presented. There are many more, the elucidation of which should be enjoyable to many physicians or intelligent laymen who have a desire to understand some of the complexities of this phase of aviation.

Commander Gemmill writes clearly, and has the capacity to simplify intricate problems, a certain sign that he has an excellent grasp of his subject. I know of no other book which presents this information in such concise but at the same time comprehensive and readable fashion.

C. C. Sturgis

The Permeability of Natural Membranes. By Hugh Davson, D. Sc., Associate Professor of Physiology at Dalhousie University, Canada; formerly Demonstrator in Biophysics and Beit Memorial Fellow, University College, London, and James Frederic Danielli, D.Sc., A. I. C., Beit Memorial Research Fellow and Fellow of St. John's College, Cambridge, England. With a Foreword by E. Newton Harvey, Professor of Physiology in Princeton University, U. S. A. Cloth. Price, $4.75. Pp. 361, with 73 illustrations. Cambridge: At the University Press. New York: The Macmillan Company, 1943.

This most interesting work endeavors to give a survey of the field of cellular permeability from the modern, quantitative viewpoint. The experimental material has been selected with the view of disclosing underlying mechanisms. The authors point out, however, that many of the experiments presented are not yet amenable to clear interpretation on the basis of any of the current hypotheses.

The presentation is designed, of course, for the student of general physiology; but the chapters on hemolysis, on membrane permeability in relation to secretion, and on the kidney may be of interest to the clinician.

Recognized as primary to the whole subject is the nature of the so-called plasma membrane which separates the cell from its environment. A critical examination of this involved matter goes far toward explaining the difficulties and complexities encountered in experimentation and interpretation. The authors employ the notion of a very thin plasma membrane in their theoretical treatment. This is perhaps necessary as a first approximation to a general theory; but one wonders if this viewpoint is sufficient for all of the permeability characteristics usually encountered.

This work, although not an exhaustive treatise, represents a long forward step in an important and difficult field of physiology. The authors are to be commended for their labors of selection and exposition. Perhaps the book will accomplish their hope, that it "will assist in defining what can, and what cannot, be done by the cell membrane, by 'surface action' and by 'changes of permeability'."

Barnett Cohen

DEPARTMENT OF TECHNIQUE

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ANALYSIS OF THE TARGET CONDITION OF ROTATING ANODE TUBES WITH A SPINNING TOP

By JOHN E. WHITELEATHER, M.D.
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THE first indication of pitting, peeling and roughening of the surface of the target of a rotating anode tube is a decrease in the output. This occurs so gradually that it is usually not noticed until a previously satisfactory technique no longer produces acceptable roentgenograms. When a noticeable increase in exposure is required, one may begin to hunt for equipment failures.

If a film is exposed with an ordinary spinning disk top, such as is used to check short exposures, a peculiar alternation may be noted in the density of the dots. Quite frequently every other impulse will be light or absent. If a number of such films are made, it will be noted that this effect is not constant; occasionally several successive dots will be of normal density. Should another tube happen to be attached to the same transformer and the effect not noted on exposures with that tube, emission limited valve tubes and other mechanical defects may be eliminated.

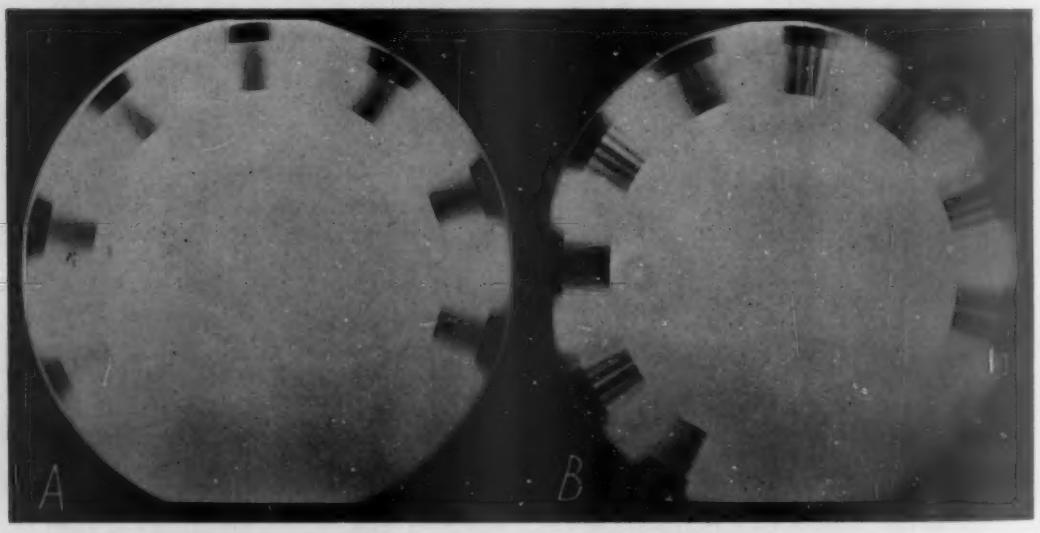

Fig. 1. *A*, normal pattern, new tube, full wave. *B*, striped, irregular pattern, old tube.

Taft and Henny[1] have described the characteristic pattern produced by target irregularities on the ionization oscillogram but the instrument they devised is not available to every roentgenologist. Roentgenograms made with a large slotted disk,

[1] Taft, R. B., and Henny, G. C. Ionization oscillograms. Am. J. Roentgenol. & Rad. Therapy, 1943, *50*, 258–263.

spinning at high speed, will give a stroboscope-like pattern which is just as characteristic.

Irregularities of the target absorb or scatter the radiation as they pass through the focal spot, resulting in stripes of variable width and density on each exposed spot. Also, since the target of most tubes rotates at from 3,000 to 3,400 r.p.m., the worst irregularities may obtrude almost in synchronism resulting in alternate light exposures on successive impulses.

Fig. 2. Anode of tube, spinning top pattern Figure 1*B*.

A rather large disk with sufficient diameter to spread the exposure of each impulse over a wide area of film will give the best results. Instead of a round hole near the periphery, a thin slot (about the width of the ordinary hack saw blade) cut radially near the edge is required. Since the top must be spun at high speed, it should not be too heavy; 1/16 or 3/32 inch steel is quite satisfactory. It could be made of brass or wood with a layer of light lead glued to the top. The spinning knob should be knurled and the disk well balanced so there will be no tendency for it to "walk" on the smooth cassettes.

Dimensions may be varied to suit the material at hand but the following have been found satisfactory. The disk should have a minimum diameter of 12 to 14 cm. The slot can be cut 2 to 3 mm. wide with a hack saw and 15 to 25 mm. deep. The outer end may be widened to 5 to 6 mm. with a thin file and the outer margin plugged with a piece of lead. Widening the outer end of the slot is not necessary but permits two different densities for each impulse. The

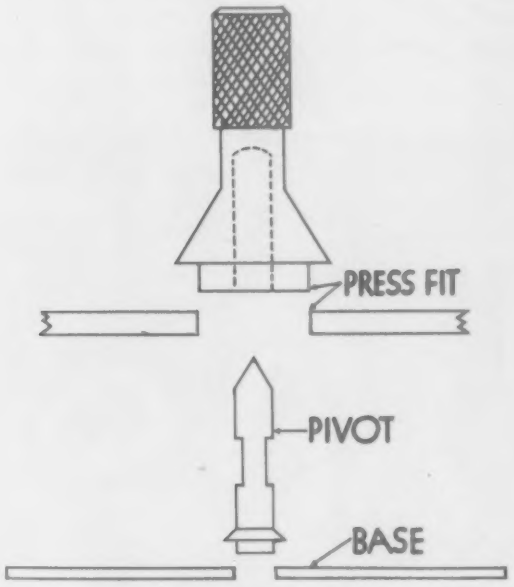

Fig. 3. Diagram of construction of spinning knob, pivot and base of top.

pivot should be so constructed as to reduce friction. If the knurled spinning knob is bored from the bottom, and press fitted into the disk, it can be spun upon a pointed pin projecting into the hole. This pin should be slotted or grooved upon a lathe so as to leave two narrow bearing surfaces as shown in Figure 3. Exposures can be made at 50 to 60 kv., 50 to 100 ma., 30 to 35 inch distance on par-speed screens.

It is important to check rotating anode tubes at intervals for surface irregularities since the targets are not visible. Roughen-

ing often occurs gradually and the decrease in detail or alteration in technique may not be noticed. The tube shown in Figure 2 first exhibited spinning top changes six months before it became so bad as to require replacement. There had been over 60,000 exposures of all types but it still operated satisfactorily in all other respects. After installation of a new tube, it was possible to reduce kilovoltage 10 to 15 kv. and improvement in detail was quite evident.

This method is well known to tube manufacturers but does not seem to be a subject of general knowledge.

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DEVICE FOR ACCURATE CENTERING OF THE STOMACH IN ROENTGENOGRAPHY*

By BERNARD WITTENBERG
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THROUGH years of experience as a roentgen technician in hospitals and private offices, I have found that accurate localization of the stomach when taking roentgenograms of patients is a practical necessity.

For better positioning as well as for economy in time and film, I have found that a simple yet accurate mask for positioning the patient during roentgenoscopy serves the purpose. The mask has been particularly valuable for centering the stomach in the Trendelenburg position and, in general this simple device has facilitated the making of gastric studies, has saved innumerable repeat examinations and has been a saving in time and cost as well as giving consistently good results.

The mask is a rectangular frame made of three ply-wood with the inner dimensions 12 by 14 inches and the outer 16 by 18 inches. It is a single piece of wood. The middle ply of the board is cut or scraped out $\frac{1}{2}$ inch wide at the inner margins, and $\frac{1}{4}$ inch strip of lead foil is glued in its place all the way around the board. Plastic wood is used to fill in the space left. On the under surface, at the four corners, are rubber headed nails about $\frac{1}{4}$ inch in diameter, to keep the mask from sliding.

White crayon or suitable markings are used to mark off the inner diameters and the center of the mask to show where to center the film in the Potter-Bucky diaphragm to the mask. Two parallel lines 12 inches apart are marked on the table top horizontally and the center line of the table is then ready for use (Fig. 1).

FIG. 1. The mask placed lengthwise on table with all markings shown.

FIG. 2. An 11 by 14 inch roentgenogram taken lengthwise in the Trendelenburg position.

Previously we used a tunnel for positioning but now find that with this simple mask there is less distortion because distance between the stomach and table has been reduced to a minimum.

Trendelenburg Position. The mask is

* From the Department of Roentgenology of the Jewish Sanitarium and Hospital for Chronic Diseases, Brooklyn, N. Y.

placed in the long axis centering the mask to table with the inner diameters 1 inch above and 1 inch below the two horizontal marks on the table.

FIG. 3. A 10 by 12 inch roentgenogram taken crosswise in the prone position.

The patient is placed in the supine position with the crest of the ilium at the lower end of the mask. The table is tilted cephalad to the angle desired. The patient is then roentgenoscoped and placed so that the stomach is centered on the mask. An 11 by 14 inch film is placed in the Potter-Bucky tray lengthwise and centered to the mask. The film is exposed with the routine technical exposure. Figure 2 shows a roentgenogram taken in this position.

Supine Position. The same procedure is followed as in the above position, only the tilting of the table is omitted. This position is used only in rare instances such as for a patient whose spinal column is one solid bridge of bone with a marked kyphosis.

Prone Position. The mask is placed crosswise with the marks centered at the horizontal lines and center line of the table. The patient is placed in the prone position, the abdomen on the mask. During roentgenoscopy, the stomach is centered to the mask in either posteroanterior or oblique position. If the patient has the asthenic or sthenic type of stomach a 10 by 12 inch film is used crosswise (Fig. 3); if slightly hypersthenic a 10 by 12 inch film is used lengthwise, although the mask is still

FIG. 4. A 10 by 12 inch roentgenogram taken lengthwise with the mask on table crosswise.

placed crosswise (Fig. 4). If the patient is markedly hypersthenic the mask is placed lengthwise on the table and an 11 by 14 inch film is used lengthwise.

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ABSTRACTS OF ROENTGEN AND RADIUM LITERATURE

ROENTGEN AND RADIUM THERAPY

WATSON, T. A. Subcutaneous x-ray therapy. *Brit. J. Radiol.*, April, 1943, *16*, 113–114.

Few carcinomatous glands are cured by roentgen therapy because they require a larger dose for cure than the skin over them can tolerate. The muscle and connective tissues around them are, however, relatively insensitive to irradiation. It is suggested therefore that a skin incision be made over the gland and the skin dissected back so that the irradiation is given only through the remaining overlying tissues. This makes the gland accessible and makes it possible to give a large enough dose to cure the gland without injuring the skin. The quality and focus-skin distance of the rays depend on the size of the gland. Probably a medium voltage treatment with a distance of about 15 cm. would prove most useful in the majority of cases.

This method has been used in about 50 cases in the past year. Because of the highly experimental nature of the method cases were selected in which only palliative treatment could be used. The disadvantages of the one large dose used in this method as compared with the fractional method may be outweighed by the high tolerance of connective tissue.—*Audrey G. Morgan.*

KOENIG, EDWARD C., and CULVER, GORDON J. The value of roentgen therapy in carcinomatous metastases to bone. *Radiology*, July, 1943, *41*, 38–41.

Many physicians and surgeons when they discover bone metastases of carcinoma simply give the patient up and keep him under morphine until death. It is pointed out that roentgen treatment is effective in alleviating pain in such cases, improving the general condition and prolonging life. Even a few months' restoration to normal life makes the treatment decidedly worth while. It is wise as a matter of routine to make roentgenograms of the pelvis and spine in cases of malignant lesions which commonly metastasize to bone. The commonest of these is carcinoma of the breast. Generally alleviation of pain can be brought about in ten days and sometimes even in five days. There is no correlation between the patient's symptomatology and general condition and the roentgen findings. Therefore treatment must be based on the patient's condition rather than on the roentgen findings. The amount, duration and site of treatment vary with each individual case. If a patient with previous cancer shows roentgen lesions in the bones, treatment should be begun even if there are no symptoms. If he shows symptoms that cannot be otherwise explained, treatment should be begun even though the roentgenogram shows no bone changes. In short, the earlier treatment is begun, the more effective it promises to be.—*Audrey G. Morgan.*

GERSHON-COHEN, J. Giant-cell tumors: radiation therapy and late results. *Radiology*, Sept., 1943, *41*, 261–267.

This report is based on a review of 29 cases. The late results with radiation treatment alone are good; among 14 cases treated in this way 2 underwent malignant degeneration, 1 six years and the other nine years after treatment; some suffered intercurrent fractures. In 14 cases treated by surgery and irradiation, the late results were also good, but there was a greater incidence of intercurrent fractures, repeated operations and infections, and the periods of illness were longer. Fixation or splinting is of great value, no matter whether surgery or irradiation is used. Intercurrent fractures can generally be avoided by relieving the bone of weight bearing. Changes in the technique of irradiation did not seem to make much difference in the rate of healing.

Many patients do not respond to irradiation well at first and recalcification may be delayed for many months. Giant cell tumors generally originate in or near the cortex and gradually extend into the marrow cavity as growth progresses. They seldom if ever extend across the line of the epiphysis before fusion. The closeness of giant cell tumors to the growing epiphysis before fusion is a complicating factor in their roentgen treatment. If the total dose is no

more than 2,000 to 3,000 r—and this total may not be necessary—the growth of the epiphysis is not materially affected. There are more apt to be secondary atrophic changes of overlying soft tissues which affect joint function.

The best treatment of these tumors would seem to be roentgen irradiation alone given in close cooperation with the surgeon. The percentage of cures with irradiation alone is possibly as high as 85 per cent or more.—*Audrey G. Morgan.*

Driver, J. R., and MacVicar, Donald N. Cutaneous melanomas; clinical study of sixty cases. *J. Am. M. Ass.*, Feb. 6, 1943, *121*, 413–420.

The great majority of cutaneous melanomas arise from pigmented junction type nevi in the skin. In color these nevi vary from slate blue to bluish black or various shades of brown to jet black with lighter and darker shades often present in the same lesion. These precursor lesions are usually smooth and flat but occasionally may be raised with a verrucous or wrinkled surface and are nearly always soft. The number which become malignant is extremely small. The authors believe that the soft flat slate blue, bluish black and black moles are the most dangerous. Also those developing later in life are more apt to become malignant and show a tendency to metastasize earlier.

Melanomas include tumors called malignant melanoma, melanocarcinoma, melanoepithelioma, nevocarcinoma, melanoblastoma and melanosarcoma. There appears to be no particular difference in the degree of malignancy of the various types. However, it is well known that the well differentiated tumors are the most dangerous because of the tendency to early metastasis. The first change in the transition from a benign pigmented melanotic nevus to a melanoma is most likely to be an increase in the size of the lesion by peripheral extension and by an increase in pigmentation. A flat lesion may become raised and indurated, and this is followed by bleeding, ulceration and the development of fungoid tumor masses. Radiating projections of pigment may be seen in the surrounding normal skin and indicate local dissemination. An increase in pigmentation is an early warning sign.

Metastasis occurs comparatively early. Dissemination may occur by way of the superficial lymphatics of the skin, in which case nodules or pigmented areas develop in the neighboring skin. If spread is by the deep lymphatics, the regional lymph nodes become enlarged, discrete and hard. Frequently dissemination may be through the blood stream.

Concerning the treatment of pigmented moles, opinions vary from the removal of no moles to the removal of all of them. There is general agreement among authors that if pigmented nevi are to be treated at all they should be thoroughly destroyed or excised, with a liberal margin of healthy tissue. The authors remove pigmented junction type nevi for prophylactic and diagnostic purposes, if located on areas subjected to chronic irritation. This has been done by scalpel excision, with a margin of approximately one-half inch of healthy tissue, including the subcutaneous tissues. In some instances thorough destruction by the electrocautery or electrodesiccation has been employed. They believe that these lesions should not be treated by irradiation or by any method requiring repeated treatments. In the treatment of melanoma, the method is not so important as long as the melanoma is completely surgically excised or thoroughly destroyed. Wide scalpel excision was performed in the majority of instances, while electrodesiccation or the electrocautery was employed chiefly in early clinically suspicious lesions that were small in size. Follow-up irradiation to the operative field with filtered roentgen rays, with Coutard technique in doses of 5,000 to 8,000 roentgens, was employed in 6 cases in this group. In summarizing, it is stated that of a series of 60 patients with melanomas, a group of 25 patients seen in hospital surgical practice presented themselves for treatment, comparatively late, with relatively advanced malignant growths and a large percentage showing metastatic involvement. Only 2 patients are known to be alive more than five years later. The mortality rate was 92 per cent. Of the other group of 35 patients seen in dermatologic practice 17, or 48.6 per cent, survived from seven to eighteen years. As a group these patients were seen comparatively early in their disease and the great majority were free of metastatic dissemination when they were first treated. The results obtained indicate that the only hope of reducing the high mortality rate in cutaneous melanoma lies in early diagnosis and thorough destruction of the primary lesion before dissemination takes place.—*S. G. Henderson.*

Colby, Fletcher H., and Schulz, Milford D. A review of carcinoma of the bladder treated by supervoltage x-rays over a five-year period. *Radiology*, 1943, *41*, 371–377.

During the five year period since a 1,000 kv. unit for the treatment of deep-seated malignant new-growths was installed 139 cases of cancer of the bladder have been treated at the Collis P. Huntington Memorial Hospital in Boston and the Massachusetts General Hospital. In both hospitals daily doses of 300 to 400 r (in air) were given, alternating through anterior and right and left oblique fields. The total radiation given to each field was 2,400 to 3,000 r. This course was followed by a second in three to four weeks with 1,200 to 1,600 r to each field. Occasionally a third smaller course was given after another three weeks.

The authors believe that operable bladder tumors are still best treated by as radical operation as possible followed by the implantation of radium, or in some cases by total cystectomy. The best results from external irradiation were in non-papillary infiltrating tumors of a high grade of malignancy while large papillary tumors of the lowest grade of malignancy showed the least response. That is, the more rapidly growing and undifferentiated the cells, the better the effect of irradiation.

In about half of the cases there was relief of pain and discomfort. Excessive bleeding was usually controlled and some cases were so much improved in this respect that they became operable. The skin tolerated the dosage given very well; there was only a slight skin reaction. Proctitis with diarrhea and cystitis developed in many cases during the last week of treatment but could be controlled. Tables are given showing end-results of treatment and life expectancy. The authors believe high voltage treatment has brought about some improvement as their cases show 40 in 100 chances of the patient's being alive four years after onset of the disease while the statistics of Nathanson and Welch to within three years of the institution of high voltage therapy show only 20 chances in 100.

The table shows that 46 patients survived for only six months, 39 for six months to a year, 22 for a year to a year and a half, 18 for a year and a half to two years, 6 for two to three years, 4 for three to four years, 2 for four to five years and 2 for more than five years. These last 2 are still alive. The best results were seen in a group in which the tumors were so much reduced by external irradiation that radon seeds could be implanted. Among a group of 13 such cases, 9 are still alive after more than a year, 4 for over two years and 2 for over four years.—*Audrey G. Morgan.*

Neary, G. J. The physical aspects of intracavitary radium treatment of carcinoma of the cervix uteri. Part I. *Brit. J. Radiol.*, Aug., 1943, *16*, 225–233.

Intracavitary radium has been found to be a better treatment for cancer of the cervix than external roentgen irradiation. In studying the question of the efficacy of radium alone, it is necessary to know the anatomy of the lymphatic drainage of the pelvis, which is described in relation to the application of radium. An analysis is given of the distribution of dosage from the uterine applicator and it is found to be poor. The distribution of dose from the vaginal applicator is found to be considerably better than that from the uterine applicator. The anteroposterior position of the radium sources is much more important than the lateral position. The distribution of dose from uterine and vaginal applicators combined is analyzed and the optimum arrangement described. The position of the vaginal applicators in most techniques is relatively unimportant. Improvement can be brought about only by modifying the uterine applicator or increasing the amount of radium in the vaginal applicator.

The effect of the radium on the rectum is considered and it is found that a single central source of radium is better than two sources in the vagina. The optimum arrangement is described; it is found to consist normally of a single vaginal applicator without a uterine applicator.

Possible clinical improvements are considered, such as the use of a platinum absorber to shield the rectum, and a modification of the uterine applicator by concentrating the radium at the fundus. The improvement brought about in this way involves a considerable increase in the total number of milligram-hours but there is no danger if suitably designed applicators are used. The integral dose still remains much smaller than the roentgen-ray dose.

The tables and calculations on which these conclusions are based are given.—*Audrey G. Morgan.*

Neary, G. J. The physical aspects of intracavitary radium treatment of carcinoma of the cervix uteri. Part II. *Brit. J. Radiol.*, Sept., 1943, *16*, 263–269.

The Donaldson technique is discussed and the method of measuring the dosage rate described. The technique consists normally of three radium applications of twenty-four hours each, the first interval being one week and the second two weeks. In both vaginal applicators the filtration is 0.5 mm. platinum, plus 2 mm. of silver, the two being equivalent to 1 mm. platinum. The vaginal applicator is the butterfly pessary, consisting of two boxes on two arms attached to a central stem. The distance between the boxes may be changed by changing the angle of inclination of the arms. During treatment the boxes lie in the lateral fornices. The uterine tube is about 6 cm. in length and 6 mm. in diameter and is slightly bent at the middle to correspond to a moderate anteflexion of the uterus of 15°. A diagram of the arrangement of the applicators is given and tables showing the dosage rates at various points in the pelvis. The dose in the parametrium is 6,750 r, while that in the first principal lymph node near the lateral wall of the pelvis is 1,900 r. The measured values agree well with the calculated values. The dosage rate at the anterior wall of the rectum is about 3,000 r. Because of the rapid variations with change in position it is not possible to give a typical bladder dose. It may perhaps be tentatively estimated that the dose at the internal orifice of the urethra is about 3,600 r in seventy-two hours total irradiation. The dose at the internal orifice of the obturator canal is not more than 1,400 r, with a strongly anteverted uterus. Dosage rates in the immediate vicinity of the vaginal boxes were examined and the figures are given. There is no evidence that the vault of the vagina receives higher doses with the boxes than with corks. Very little of the mucosa receives more than 14,000 r. It is evident that a box serves as a point source of radium at distances beyond 2 cm.—*Audrey G. Morgan.*

Harvey, Roger A., and Ritchie, Robert N. Carcinoma of the cervix complicated by complete procidentia: radiation therapy. *Radiology*, July, 1943, *41*, 48–51.

The author reviews 78 cases of procidentia with carcinoma of the cervix reported in the literature and describes a case of his own in a white woman eighty-one years of age. He treated his case with 3,600 r, measured in air, and given over a period of thirteen days. The tumor shrank to half its original size and the prolapsed uterus receded into the vagina. The patient was then given a total dose of 3,500 milligram-hours radium. A year after treatment the patient reported that she had no pelvic symptoms at all and was in good health.

It is better in these cases to give roentgen treatment before radium for the initial use of radium would result in unequal distribution of the rays in the tumor and adjacent tissues. These tumors are still quite generally treated by surgery. This is the second case recorded in which irradiation alone was used. In view of the results the author advises deep roentgen therapy followed by radium.—*Audrey G. Morgan.*

Riches, E. W., Williams, I. G., and Haddow, Alexander. The treatment of carcinoma of the prostate. Symposium. *Brit. J. Radiol.*, July, 1943, *16*, 187–198.

Riches discussed symptoms, treatment and results in 70 cases of carcinoma of the prostate. About 20 per cent of patients with prostatic obstruction have malignant disease. There are two types of carcinoma of the prostate—primary carcinoma developing in a previously normal gland and carcinoma developing secondarily in a prostate already hypertrophied or affected by adenoma. The symptoms in the two types are the same and are those due to obstruction. Additional symptoms are caused by metastases which are more frequent in the lymphatic glands than in the bones or viscera. The internal iliac glands are most frequently affected—in 73 per cent of the cases in Muir's statistics and this limits the possibilities of surgical treatment alone. The prognosis depends on the degree of advancement of the disease when first seen and on its clinical and pathological type. The author has never seen a case of actual cure of carcinoma of the prostate but one of his patients survived ten years and then died of recurrence. Length of survival is increased by the association of radiotherapy with surgery, and pain is decreased. Treatment of a diagnosed case by endoscopic resection and roentgen irradiation gives an average survival period of nearly two years, while treatment of an unsuspected case by prostatectomy and roentgen irradiation gives an average survival of more than three years.

Williams discussed the radiotherapy of carcinoma of the prostate, emphasizing the importance of such localization and beam direction as to permit of the use of smaller fields and an increase of the tumor dose to high levels without undue exposure of normal tissues. He thinks the future progress of radiotherapy of prostatic carcinoma depends on the working out of greater accuracy of beam direction and possibly on the use of higher voltages. He has had no experience with interstitial radium therapy but thinks it may be useful if the greatest possible homogeneity of dosage is attained within the tumor and the paths of spread dealt with by external irradiation.

Haddow discussed the increase of acid phosphatase levels in the blood in carcinoma of the prostate, particularly in metastases. This high level decreases after castration and there are both local and general signs of improvement in the disease. There is a study of the clinical and pathological effects following the administration of estrogens in this disease and attention is called to the practical results which may follow the apparently theoretical study of chemical and biochemical problems, such as the acid and alkaline phosphatase content of the serum in different conditions.—*Audrey G. Morgan.*

Maxfield, J. R., Jr., McIlwain, A. J., and Robertson, J. E. Treatment of radiation sickness with vitamin B_6 (pyridoxine hydrochloride). *Radiology*, Oct., 1943, *41*, 383–388.

It has been difficult to determine the cause of irradiation sickness but it now appears that it is much more apt to occur in patients suffering from malnutrition, debilitation and avitaminosis. The radiologist himself should see to the nutritional balance of his patient and not leave it to the attending physician. Vitamin B_1 and the vitamin B complex were first tried in the treatment of this sickness but they were not always effective. The authors then began the use of vitamin B_6 (pyridoxine hydrochloride), giving 25 mg. intravenously per day. They now recommend that this dosage be repeated at intervals of twenty-four to seventy-two hours as needed during the rest of the radiation treatment. They have had excellent results in 50 cases. The drug is safe, simple to give and has no contraindications. A table is given showing the treatment and results in 22 cases. There was failure in only 1 case, in which the drug was given intramuscularly. When the patient was subsequently given further irradiation the drug was given intravenously and the results were good. Other methods of treatment, such as the use of liver extract, a high vitamin intake, the use of sedatives, etc., are to be encouraged in connection with this treatment if they are needed.—*Audrey G. Morgan.*

MISCELLANEOUS

Pohle, Ernst A., McAneny, John B., and Lovell, B. K. Radiation therapy in carcinoma of the rectum and sigmoid. An experimental study of the "danger" dose of roentgen rays for the intestinal mucosa in dogs and an analysis of 195 cases treated in the State of Wisconsin General Hospital during 1928–38. *Radiology*, Sept., 1943, *41*, 225–232.

It cannot be said that irradiation alone will cure any considerable percentage of carcinomas of the rectum and sigmoid while radical operation in the early stages of the disease gives a five year survival rate of about 50 per cent. No data could be found for the tolerance dose of the rectum or sigmoid so the authors performed experiments on dogs to determine the "danger" dose for intestinal mucosa. Nine adult dogs with an average weight of 10 kg. were irradiated with doses of 600, 900, and 1,200 r (in air) per field. The treatment was given all at once except in one case in which the fractional method was used. The dogs given a dose of 1,200 r died in 14, 48 and 52 days after the treatment. Those given 600 r had little or no reaction in the mucosa though they suffered roentgen sickness for some three or four weeks. Those given a dose of 900 r showed ulceration and perforation of the rectum.

There is also a discussion of 195 cases of cancer of the rectum and sigmoid treated at the Wisconsin General Hospital. The percentage of five year survivals was very low, but many of the patients came with quite advanced lesions and a good many did not return to complete the course of treatment prescribed. It is impossible from this series to determine with any degree of accuracy the value of postoperative irradiation. But there is no doubt that preoperative irradiation often renders an inoperable tumor operable by relieving fixation. It is also true that considerable palliation can be brought about by roentgen treatment or roentgen rays and radium combined, and metastases, especially in bones, are distinctly benefited by roentgen therapy.—*Audrey G. Morgan.*

Raab, W., and Soule, A. B., Jr. Effect of roentgen irradiation on the hormone content and secretion of the adrenal medulla. *Radiology*, July, 1943, *41*, 56–60.

The adrenal region in white rats was irradiated with roentgen doses of 100 r and 1,000 r. Tables are given showing the details of the results. There was no significant change in the hormone content of the medulla of the glands within sixty-eight hours. The early increase in weight of the glands within sixty-eight hours after a dose of 1,000 r was due to the initial hyperemia. But after sixty to sixty-eight days there was decreased secretory activity after a dose of 100 r and a similar decrease, combined with slightly decreased hormone production, after irradiation with 1,000 r.

Other investigators have found a specific depression of irritability of the sympathetic nervous system, of which the adrenal medulla is a part, on roentgen irradiation. This is consistent with the findings of Raab in previous work, which showed an abnormal discharge of adrenal hormone into the blood within a few minutes after exercise in patients with angina pectoris. On roentgen irradiation of the adrenal region this abnormal discharge stopped and essentially normal conditions were restored. Subjective symptoms were also overcome and the electrocardiogram became normal. Evidently the irradiation depressed the abnormal secretory activity of the glands.

No significant structural changes were found in the adrenal glands of 3 patients who had been treated from a few weeks to thirteen months before death.—*Audrey G. Morgan.*

Tchaperoff, Ivan C. C. Preliminary notes on the effect of roentgen rays on sulfonamides in vitro. *Radiology*, July, 1943, *41*, 61–63.

The author discusses work done on the sulfonamides at the Vancouver General Hospital, Vancouver, B. C. It has been found that while both roentgen irradiation and sulfonamides are beneficial in inflammation, they are useless or even harmful if used together. The author's experiments were made with the object of determining whether under the action of irradiation the products of break-down of the irradiated drugs might have an unfavorable action, either stimulating the growth of bacteria or injuring the tissues.

He used stock solutions of pure sulfanilamide and sulfathiazole and irradiated them with unfiltered radiation. A table is given showing the details of the results. The two drugs are equally changed by irradiation, the change apparently being an alteration of the NH_2 group. As the sulfonamides can be broken down by irradiation in vitro it is probable that they can be broken down by much smaller doses in the body and it is probable that the break-down of even a small fraction of sulfonamide neutralizes the beneficial action of a much larger quantity of the unirradiated drug. The exact nature of the compounds produced by the irradiation of the sulfonamides is not known. These drugs have a bacteriostatic action and it now seems probable that irradiation also has such an action; it is a chemical action which directly inhibits the growth factor of bacteria.—*Audrey G. Morgan.*

Lasnitzki, Ilse. The response of cells *in vitro* to variations in x-ray dosage. *Brit. J. Radiol.*, May, 1943, *16*, 137–141.

Irradiation of cultures of the choroid and sclerotic of chick embryos with doses of 100 and 1,000 r has been described in previous articles. This article deals with the irradiation of the same kind of cultures with doses of 2,500, 5,000 and 10,000 r. Tables giving the details of the results and plates showing the appearance of the cells are given. These larger doses brought about breaking down of the cells soon after irradiation. The greatest number of degenerate cells were seen with all these dosages three hours after irradiation. Cell death with the lower doses seemed to be associated with the entry of the cells into mitosis. It has been shown that if the cells are prevented from entering upon mitosis after irradiation, for instance by cooling, degeneration does not take place. But with the higher doses used in this series of experiments the cells break down in the resting condition.—*Audrey G. Morgan.*

Dale, Walter M. Effect of x rays on aqueous solutions of biologically active compounds. *Brit. J. Radiol.*, June, 1943, *16*, 171–172.

This article discusses a series of investigations on the effect of irradiation on enzymes. It was found that dilute solutions of enzymes were radiosensitive and could be almost completely destroyed by a small dose, while concentrated solutions were radioresistant and apparently unaffected by irradiation. This is called the dilution phenomenon. It was also found that enzymes were protected when irradiated with

their substrate. This is called the protection phenomenon. The dilution phenomenon is explained by the fact that the irradiation acts primarily on the water and forms intermediate products which in turn act on the substances in solution. Another reason why enzymes have been considered radioresistant is that they were often subjected to irradiation in an impure state without the protective action of other substances being taken into account.

It is hoped that a further study of the indirect action of irradiation on enzymes, and of the dilution and protection phenomena will bring about a better understanding of the effects of radiation in the more complex field of the living body.—*Audrey G. Morgan.*

Gray, L. H., Read, John, and Poynter, M. The effect of ionizing radiations on the broad bean root. Part v. The lethal action of x radiation. *Brit. J. Radiol.*, 1943, *16*, 125–128.

The authors have previously studied the lethal effect of gamma rays, neutrons and alpha particles on the broad bean root. This paper reports the results of exposure of the bean roots to roentgen rays having a mean wave length of about 0.16 Å under comparable conditions which are described, and tables and graphs showing the results are given.

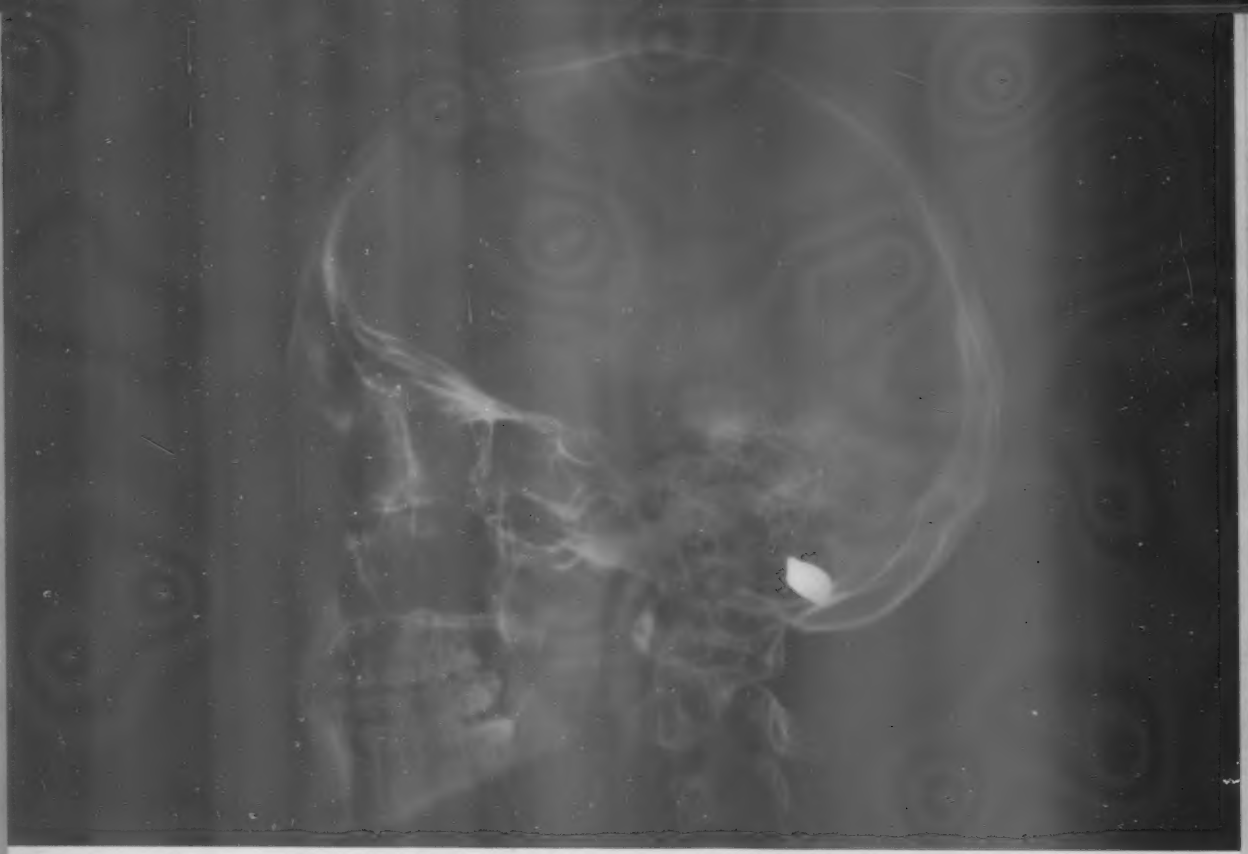
If all other factors are kept equal there seems to be a general tendency for the biological effectiveness of roentgen radiation to be greater than that of gamma radiation, a difference which is almost certainly correlated with the difference in the linear density of ionization along the tracks of the ionizing particles generated by the two kinds of radiation. The difference in ion density between roentgen and gamma radiation is, however, so small that such differences in efficiency as exist would be hard to demonstrate experimentally.—*Audrey G. Morgan.*

Parker, H. M. Limitations of physics in radium therapy. *Radiology*, Oct., 1943, *41*, 330–336.

The author discusses the Paterson-Parker system of charts on which dosage and the distribution of radium radiation around various applicators is based. He says that the system falls short of the mathematical ideal by permitted tolerances. It is questionable whether these tolerances are acceptable in view of other possible errors in radium therapy or whether a more accurate system should be sought. Perfect implantation is limited by the number of sources that can be introduced without excessive trauma, the skill with which they are inserted in the desired position and the reconstruction of the implant for accurate dosage calculation. Even a perfect distribution would be modified by absorption and scatter in tissue and it would be unwise to elaborate a system to closer limits than the changes brought about by these causes. The original system took cognizance of oblique filtration only in special treatments with long single sources. In all cases the dosage rate in some parts of the irradiated area will be reduced by oblique filtration. Variously shaped applicators are illustrated and the dosage distribution worked out. Calculations with radium tubes are based on the assumption that the tubes are properly filled. Bad packing may lead to serious errors. Curved surfaces are not amenable to good mathematical treatment and the error in determination of the area treated with such curved surfaces may be as large as 10 per cent. It is not easy to mount radium tubes on wax or similar applicators so that they will be within 0.5 mm. of the correct distance. It is always advisable to supplement dosage calculation by direct ionization measurement. Reading at selected points can correct the principal errors in dosage rates. The author has found closer agreement between measured and calculated doses than would be expected from the many possibilities of error.

In the discussion Major Friedman called attention to the difficulties in the use of the intrauterine tandem in the treatment of carcinomaor the cervix. It is made by placing several radium capsules inside a rubber tube; a cotton plug is then inserted to fix the radium in position and the rubber tube is tied with a thread. When this applicator is inserted into the uterine canal the lowest radium tube will often lie just above the cervix, which is occupied by the cotton plug, the thread and the distal empty part of the rubber tube. Moreover, the oblique radiation of the lowest radium capsule is often such that the dose to the cervix is reduced.

Dr. Parker replied that interstitial treatments are up to the clinician. Treatment within the cervix is a subject that no physicist likes to handle.—*Audrey G. Morgan.*



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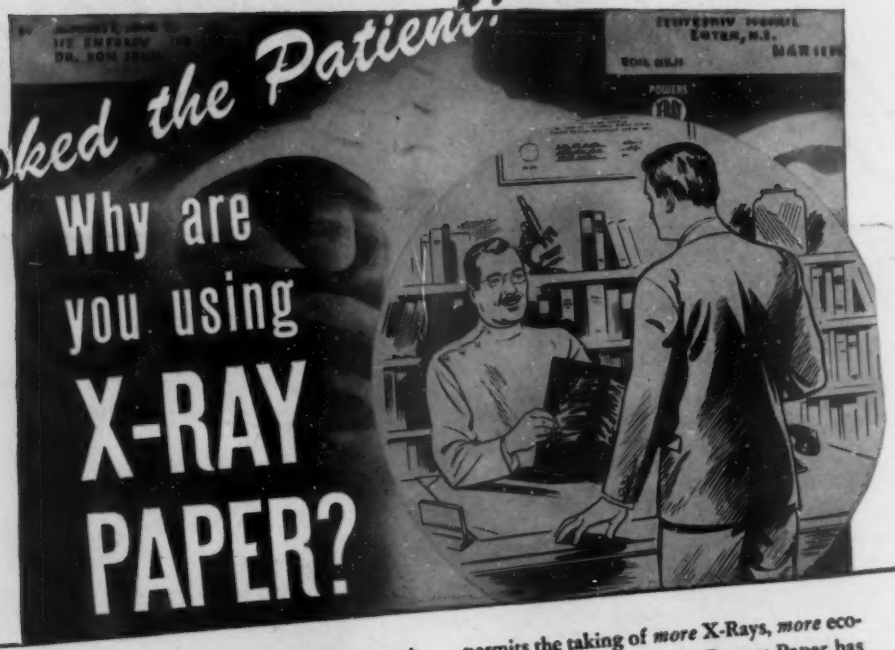

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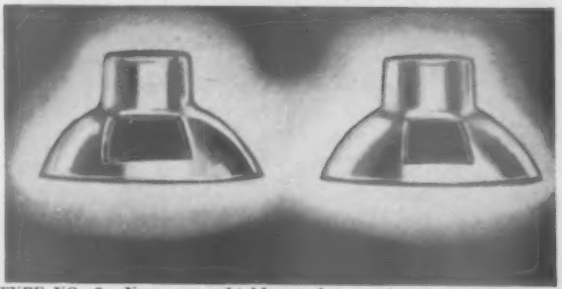

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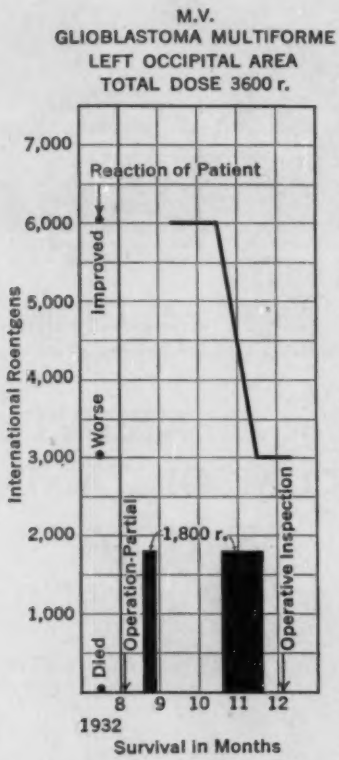

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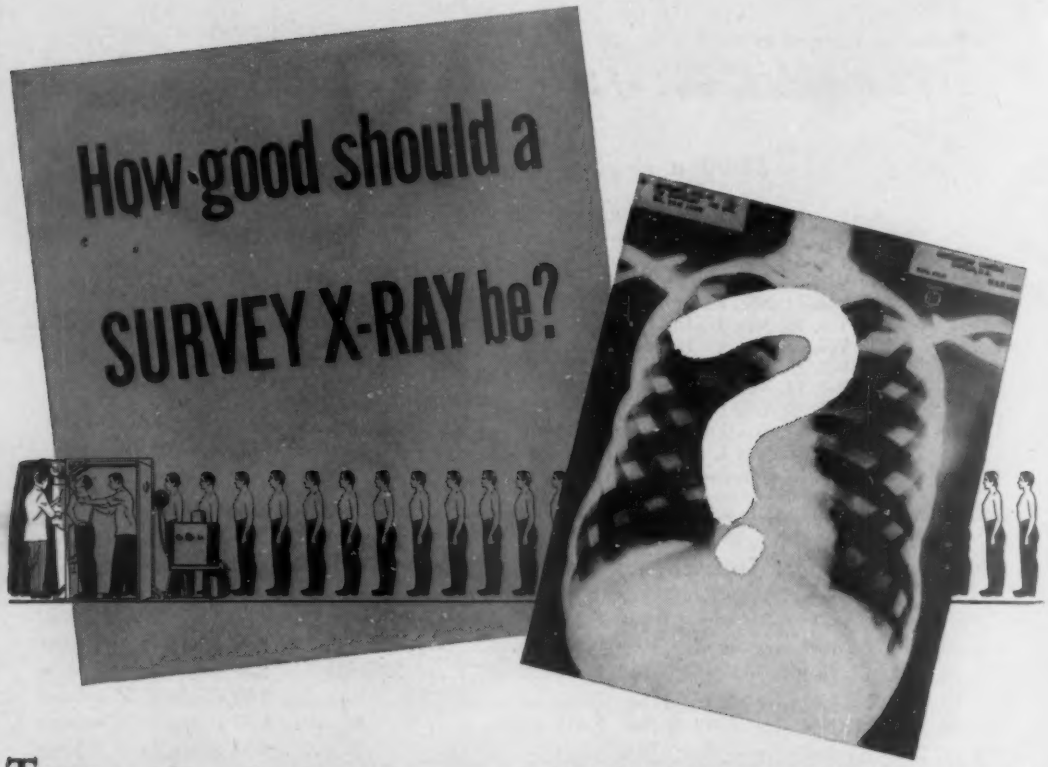

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